THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science,

HALIFAX, NOVA SCOTIA.

VOLUME XI.

PART 4.

SESSION OF 1905-1906.

HALIFAX:
PRINTED FOR THE INSTITUTE BY MCALPINE PUBLISHING CO., LTD.
Date of Publication:—August, 1908.

PRICE TO NON-MEMBERS: ONE HALF-DOLLAR.

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THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications :—

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible.

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or anonymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotations, such as that recently adopted by the French Zoological Society"

PROCEEDINGS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1905-1906

Annual Business Meeting.

Legislative Council Chamber, Halifax, 18th October, 1905.

The President, Dr. Henry S. Poole, in the chair.

Presidential Address.—By Henry S. Poole, D. Sc., F. R. S. C.

The Institute's Work.

We are once more met together to hold an annual meeting, to receive reports, elect officers for the ensuing year, and open another session of this Institute. During the year that has closed, we suffered no loss of members, and the interest taken in the meetings remained at the standard customary of late.

The additional movement established a few years ago, viz. the popularizing of special meetings, has been continued with a gratifying attendance. Advantage was taken, through Mr. Jenney's kindness in placing his electric-lantern at the service of the Institute, the better to display the carefully prepared and attractive illustrations of volcanoes which Dr. Woodman was enabled to use at his lecture to an appreciative audience. It will be noted that half the papers read and submitted at the last session were more or less geological. This should create no surprise in a province so given over to mining, and possessed of so wide a range of strata well exposed for study. Of a different class was the paper of Mr. W. H. Prest on "Edible Wild Plants of Nova Scotia," which brought to

the meeting when it was read, many members of the Botanical Club of Halifax, and which led to a discussion of much interest, that showed that all had not been learned of the twigs, leaves, barks and roots, which in cases of emergency would be available to sustain life. The facts brought out at the discussion, in addition to those given by the author, suggest that much good would ensue at future meetings were the custom established of getting members and their guests to submit in writing, for publication with the primary paper, remarks thereon. Not only would a writer be gratified by the notice his article elicited, even when there was not entire agreement, but the subsequent reader of the paper would have also a knowledge of the measure of credence or endorsement given to the statements made at the time of presentation.

It was most unfortunate that the Kings County Branch of the Institute, at Wolfville, was unable to hold meetings during the year. This was due, however, to no lack of interest in the branch, which was organized in 1901.

The finances of the Institute have received the careful attention of the Treasurer, and his report will be submitted:

The Recording Secretary, I was on the point of writing, gave me invaluable assistance in the work of calling the meetings, preparing statements, keeping accounts and editing the transactions; but I am sorry to say I cannot truthfully do this, for it was not merely assistance that I got from him. The fact is, he was the head and front of the Institute the past three years, and saw to everything. We have taken so much as a matter of course the services he has given, that I fear we have not fully appreciated the sacrifices he has made, sacrifices which the Institute cannot expect to continue forever, especially as he has duties in other directions which are constantly growing. His is an interesting case of early training to a sense of moral obligation, that I am selfishly thankful extended to the end of my term of office, and I now would make all due acknowledgments.

Speculative Thoughts.

And now before giving place in this chair to a busy man of practical ideas, let me give utterance to a few vague speculations of idle moments.

When man wakes to consciousness in this material world, he finds himself one of many varied organisms, stamped with one general plan, automatic in part, and also in possession of a limited amount of free-will and action. As he becomes sensible of his position, and his bodily wants are met, he begins to realize he is not so very independent or all-powerful, and that he is living on a borderland of mysteries, surrounded by the inexplicable, and when considered from a purely personal point of view, by what seem malevolent as well as benign influences. The limitation to his powers meets him on every hand, and he finds his very existence depends on the range of the forces to which he is exposed being circumscribed. He finds, moreover, his consciousness of sensation also has its limits, as of sound proceeding from pulsations only within fixed amplitude and frequency, the limit of perception varying somewhat with the individual, in harmony with the variability of moderate degree everywhere observable in nature. Light and heat also have to be restricted in their range if they are to be utilized by man, while excess of the latter is made evident beyond doubt by destruction of tissue.

At times man glories in the freedom he possesses, and especially when he makes subservient to himself beings weaker or mentally less endowed, beings whose sum of animal existence is to eat and to be eaten, for few individuals in the ferine state escape the latter condition, and, as a matter of fact, few animals of any condition.

As consciousness develops, and with a mind free of anxiety for immediate wants, he seeks to know who and what he is in this world's economy, whence he has come, and whither will he go. His untrained perceptions failing him beyond the compass of self-preservation, he consults his fellows for their knowledge of these matters. He becomes a student and so far as his enquiries and experiments are systematic, a student of science.

Here, as in all cases of disturbance, whether physical or mental, opposition is met with, and the student of truth has to contend with errors of observation and assumption of conclusions unproved. The latter especially hampers him, for recognizing his seeming hopeless ignorance of much there is about him, he is only too ready

to accept the confident assertion of another individual grasping every opportunity for self aggrandizement.

As a student he has first to carefully confine his observations to that which is material and to oft trodden paths, to accept nothing as true which cannot be put to the test over and over again, since isolated cases, however suggestive of the truth of certain contentions, may mislead when all conditions of a problem have not been noted. Further than this faith in the teachings and reverence for the fathers of modern science are not inculcated to pass beyond respect. Their deductions of yesterday are subject to the cold criticism of to-day equally with the latest theory of the youngest tyro; and as for flights of fancy and the poet's glamour, they are not needed to enhance admiration, awe and wonder of the mysterious marvels that unfold themselves to his growing intelligence.

In the schools of chemistry and physics, natural phenomena have no sporadic mysteries, though their controlling source be obscure, and vast ignorance respecting them necessarily still prevails. Repeated proof is essential, since fortuitous concurrences mar the accuracy of findings based on solitary examples. The world is full of superstitions derived from hasty generalizations, and many have come down from pagan times and been engrafted with modern belief.

The teachings of the nursery, with its first and indelible impressions, have a lasting effect, and we grow up creatures largely of habit, indisposed to put aside pre-conceived opinions and even perhaps unable to dispassionately consider, on their merits, questions touching ourselves. This innate tendency of the mind to keep alive the lore impressed in childhood and clung to generation after generation, is in keeping with ancestral characteristics of the body which we note in ourselves and our neighbours, and which the breeder of choice strains of animals and plants is particular to propogate.

The unbiassed student will take the stand that the intelligence with which he is endowed calls for it exercise and growth; that he is warranted in searching into all that appertains to himself and his surroundings, although his powers are restricted and he is incapable of reducing to order a fraction of the mysteries about

him; unable to grasp an idea either of creation or annihilation, or a condition preceding the one and succeeding the other, or of a beginning or ending of time or limitation of distance. While there is much that he cannot hope to understand, there are suppositions he cannot possibly accept, as that of birth without resultant death, nor can he conceive of mental sensations, as joy, love and hope, without crediting the converse possibilities. There would be for him no pleasure if there were no pain, no recognition of light without that of darkness, nor of heat without cold. The perception of the one necessarily demands the condition of the other. All nature teaches this to be a truth, analogy with cause and effect, is everywhere constant, whether it be among phenomena typified by the satisfying of an acid for its base, or among an entirely different group exemplified in the fatigue which follows strain.

Reverting for a moment to pain, to excruciating pain, which some people tell us they find hard to reconcile with their standard of faith, let us picture a stricken creature, the moment before stored with vitality, now the innocent victim of an accident which deprives his nervous energy of control, and lets loose the impulses which ordinarily are used only slowly as required for the well-being of the body. No longer under restraint, these become intensified with a correspondingly rapid exhaustion of vitality, and the dews of anguish mark that intensity as beyond endurance. It is like the burning of a candle at both ends in oxygen, the sum total of stored energy is there used up in a very short time.

When the student awoke to the value of classifying his observations and realized that order prevailed even among details apparently dissimilar, great advance was made, and he was then able to satisfy himself by repeated experiment that phenomena of nature were subject to fixed relation which could be expressed as laws, and he was also able to convince his fellows that, under similar treatment, like results would ensue in their hands.

Besides the phenomena he has systematized, he reasonably assumes by analogy that there are others equally amenable to elucidation, although efforts in many directions have so far met with but indifferent success.

Retrospection raises hope to pursue further investigation among the unexplained mysteries even of the organic world. Who a century ago would have thought it possible to harness lightning to a car, to prove a similarity of chemical elements in other worlds than ours, to see with ordinary vision through walls of common brick, to hear a whisper along one thousand miles of wire, or instantly communicate through the air far beyond the reach of sight and sound? The success the student has achieved in pushing back the fringe of the great unknown, has enabled him the better to realize he is subject to a reign of law, and it has elevated his perception of the infinite and the sublime.

At the same time it is equally true that that opposition to movement of whatever sort or kind which, as already has been stated, seems an essential corollary to it, is apt to lead in us, as individuals, to pride in the dominant position we hold on earth, and leads us to forget we are but as flies on the wheel, chips on the torrent, or grains of sand in the whorl of the cyclone: even to proclaim "We and God," when a coupling with the beast of the field would be more in keeping with man's worldly relations.

There is also a growing belief among naturalists, who have closely observed wild life at home and free of fear, that what in man are called the finer feelings—friendship, affection and sympathy, are exhibited in a marked degree by creatures of more humble circles.

The student, moreover, has reason to suspect that as in the material world law and order reign, so also among the spiritual influences affecting free will, system prevails. Further than that, as there is to the individual a birth, maturity and death, and to communities a racial or national rise, a period of prosperity and ultimate decay, so does it appear in the non-material region of thought that a cycle holds good; that there have been to religions an inception, a zealous purpose, an acceptance, and then decline; also to ideas in other directions there comes the inspiration, the spread of waves of intelligence throughout communities in sympathy, and then a subsidence of the particular impulse, like as it is with epidemics of pestilence and accident.

Views of this sort are not entirely new; something of the kind was expressed by ancient writers, although it was left to modern times to more fully confirm the mastery of law and order, and the idea that activity meant the breaking away from harmonious quiescence. Later ideas have recognized a similarity of purpose in mundane interests which extends beyond a daily reawakening from unconsciousness to a state of bodily and mental activity with memory of previous periods of consciousness in the individual. It includes the replacement of units and the succession of dominant races. It goes even further and assumes the law of cycles to include in its grasp intangible impulses, the temperament of races, the family likeness and mental atavism; embraces the reincarnation of ancestral traits of body, finding a homologue in the reappearance of mental characteristics. These when purely animal and of the automaton order, we call intuition. They direct the infant to cry, the sheep to eat grass, the wolf to devour the sheep and the bird to build a nest and migrate. Nor is this intuitive impulse confined to the animal world, it is observable in the vegetable, in the shrinking from touch and consequent tired feeling of the sensitive plant, in the night-folding flower of the *Œnothera* and in the closing over on its victim of the *Drosera* leaf. Nor is it absent from the mineral world. Among growing crystals we detect it in the interlacing spicules of ice, in a network of cyanite where each crystal in its struggle to grow greater bends about to avoid its fellow crystal imbued with a similar purport. How these several attributes are maintained and stored in the germ, must remain forever a marvellous mystery, although constant repetition would indicate a governance by law.

Recognition has been made of the existence of influences, forces or impulses, which may, from the aspect of the individual organism, be malign. These the student contends are natural concomitants of life, for the interests of the unit necessarily become subordinate to the welfare of his community and his race in their competition and struggle for continuance on the face of the earth. We have to differentiate between Man, an order of beings, and 'man' an egotistical unit whose naturally selfish aspect is to regard the world as his oyster, and whose first instinct is self-preservation. Mal-

thusian views prevail. Utopia with perfect peace, continuous bliss, joy, and love for all, is necessarily an impossibility, and encouragement of any such idea a snare to the weak and emotional. The world cannot be otherwise than one of strife, both of brain and muscle, and the struggle must continue, of the weak with the strong and of the oppressed with the oppressor, however much we may disguise the unavoidable in euphonious terms.

While excess in all things is to be deprecated, and over-indulgence in speculations in matters of science is to be avoided, a generalization or two gives a fillip to enquiry and is helpful to the student. As a stimulus to observation it may for the moment be assumed there is no reason why the same systematic and orderly approach to the fields of the unknown, which method modern research inculcates, should not be adopted also to the realms of thought, nor why we should not assume that the energy of intelligence and the limitations to voluntary action may not also be under the dominion of law. If this be so, who shall say little is left in the field of science for the observer outside the walls of a college and a laboratory?

W. McKerron presented the treasurer's report, which having been audited and found correct, was received and adopted.

The report on the library was presented by H. Piers, showing that 2,330 books and pamphlets had been received by the Institute through its exchange-list during the calendar year 1904, anl 1,354 had been received during nine months of the present year (1905), viz., January to September. Increased use of the library was also reported as shown by the number of books borrowed during the year 1904, viz. 519, as against 296 in 1903. Particulars were also given of the total number of books and pamphlets received during the year 1904 by the Provincial Science Library with which the books of the Institute are incorporated. This number was 3,115, of which 2,330 were the society's exchanges as above-mentioned. The report was received and adopted.

The secretary reported that the Kings County Branch of the Institute had not met during this session of 1904-5.

W. McKerron presented a report as delegate to the meeting of the Royal Society of Canada.

Votes of thanks were passed to Hon. M. H. Goudge, President of the Legislative Council, for his courtesy in granting the society the use of the Council Chamber as a place of meeting during the past session; and to the Secretary of the Smithsonian Institution, Washington, for courtesy in continuing to admit the Institute to the privileges of the Bureau of International Exchanges.

The President brought to the notice of the meeting a note by R. Ruedemann, assistant state palæontologist, Albany, N. Y., on three specimens of *Dictyonema websteri* from New Canaan near Kentville, Kings Co., Nova Scotia, belonging to the Webster collection, Provincial Museum, Halifax. Mr. Ruedmann reports as follows regarding these specimens:

"*Dictyonema websteri* has been figured, but not described, by Dawson in Canadian Naturalist and Geologist, vol. v, 1860, p. 139, and again figured in Acadian Geology, 1891, p. 563, but not described. Thus this species is nowhere described. A careful comparison with authentical material of *D. retiforme,* Hall, from the Rochester (Niagaran) shale in New York, fails to show any differences sufficient for specific distinction, and it is, therefore, quite sure that *D. websteri* is identical with *D. retiforme.*" He reports further that a lot of *Dictyonemas* from Benton and Monument Settlement, Carleton County, New Brunswick, and from Navy Island, St. John, N. B., labelled *Dictyonema sociale,* all belong to one species, *Dictyonema flabelliforme,* Eichwald (sp.) (= *Dictyonema sociale,* Salter [sp.], a Latin name). This species is characteristic of the closing stage of the Cambric age.

The following were elected officers for the ensuing year (1905-1906):

President—F. W. W. Doane, C. E., *ex-officio* F. R. M. S.

Vice-Presidents—Professor Ebenezer MacKay, Ph. D., and Professor J. Edmund Woodman, D. Sc.

Treasurer—William McKerron.

Corresponding Secretary—A. H. MacKay, Ll. D., F. R. S. C.

Recording Secretary—Harry Piers.

Librarian—HARRY PIERS.

Councillors without Office—MAYNARD BOWMAN, B. A.; WATSON L. BISHOP; EDWIN GILPIN, JR., LL. D., F. R. S. C., I. S. O.; ALEXANDER MCKAY; J. B. MCCARTHY, B. A., M. SC.; PROFESSOR FREDERIC H. SEXTON, B. SC.; HENRY S. POOLE, D. SC., F. R. S. C.

Auditors—PROFESSOR D. A. MURRAY, PH. D.; R. MCCOLL, C. E.

A vote of thanks was presented to the retiring President, DR. POOLE, for the very able manner in which he had filled the position during his term of office.

A vote of thanks was presented to H. PIERS for his work as secretary.

FIRST ORDINARY MEETING.

Assembly Room, Province Building, Halifax, 13th Nov., 1905.

THE PRESIDENT, MR. DOANE, in the chair.

It was announced that the following had been elected ordinary members: A. A. HAYWARD, Halifax; ARTHUR STANLEY MACKENZIE, PH. D., Professor of Physics, Dalhousie College, Halifax; ERNEST BRYDON-JACK, M. A., C. E., professor of civil engineering, Dalhousie College, Halifax; and that MONRO ARCHIBALD, B. A., B. SC., had been elected an associate member.

CAPTAIN J. H. BARBOUR, M. D., Royal Army Medical Corps, Halifax, read a paper, "On the Flora of McNab's Island, Halifax Harbour, N. S." (See Transactions, p. 553). The subject was discussed by DR. A. H. MACKAY, and a vote of thanks presented to CAPTAIN BARBOUR.

In the absence of the author, H. PIERS read a "Catalogue of the Birds of Prince Edward Island," prepared by JOHN MACSWAIN, of Charlottetown. (See Transactions, p. 570).

Second Ordinary Meeting.

Assembly Room, Province Building, Halifax, 11th Dec., 1905.

The President, Mr. Doane, in the chair.

W. E. Lishman, M. A., M. I. M. E., of Durham, England, read a paper entitled, " Mining, Is it a Science?," in the course of which he said:

" It is safe to say that mining up to within recent years has stood in its own light. It has been regarded as essentially practical, the theoretical side of it being almost entirely ignored. It used to be a *sine qua non* for one holding an official position that he should be, to borrow an expression used in coal mining, " a good pitman." We will not quarrel with this, as it is very essential that a man who is to see to the actual working of a mine should be a really practical man, and so long as mining was carried on in a rule-of-thumb fashion and simply consisted in raising comparatively easily obtained and accessible minerals to the surface, such a man was the most suitable for the purpose. But now that in many countries the process of extracting and raising minerals, so far from being the simple affair it once was, has become one of the most complicated and far-reaching that man is called upon to perform, we may well question the policy of setting so much store by the purely practical man. And be it observed that it is just at the time when mining is making this marked advance forward, when, that is, methods are becoming more and more complicated, that scientific education on its part is making a like advance. The one is in fact complementary to the other. But such is the conservatism in human nature that in spite of the increasing complexity of mining operations on the one hand, and in spite of the impetus given to technical education on the other to meet this, yet those in authority are only now beginning to give up their predilections for the 'practical man' and to go in for one who by judicious training in practical and theoretical work should in all senses of the word prove more efficient for an official position than the former. It is for this reason that I say that mining has to a certain extent stood in its own light; but it is satisfactory to notice that a change is now taking place, as indeed it was bound to do, and the value of

the scientific man is becoming more and more recognized every day. This is still further emphasized in England by the recent parliamentary enactment providing that two years' study (with the necessary diploma) at an accredited college or institution, and three years' practical experience at a colliery, may take the place of the five years' practical work which previously constituted the qualification for sitting for the examination for colliery manager's certificate. In this connection, too, it may also be observed that the Durham College of Science, Newcastle, and other universities, have recently instituted degrees in mining, being I believe the first to adopt such a course. So that it is beginning to be recognized that mining should at least be regarded from a scientific stand-point. It remains for those interested in the subject to see that this stand-point is maintained, or if possible, improved upon. It is evident, too, that much more will be expected of the future mining engineer than has been the case in the past. And necessarily so, for as the more accessible and more easily worked seams and veins are approaching exhaustion, the need for more scientific and ingenious methods of reaching those less accessible will become more pressing, and will demand all the resources we are capable of rendering."

The subject was discussed by DR. A. H. MACKAY, PROFESSOR SEXTON and DR. WOODMAN, and a vote of thanks was presented to the lecturer.

DR. A. H. MACKAY read a paper entitled, "Fungi of Nova Scotia; first supplementary list," (see Transactions, vol. xii, pt. 1, p. 119), which was discussed by DR. H. H. READ, DR. E. MACKAY, DR. A. P. REID, W. L. BISHOP and H. PIERS.

THIRD ORDINARY MEETING.

Assembly Room, Province Building, Halifax, 12th Feb., 1906.

THE PRESIDENT, MR. DOANE, in the chair.

H. W. JOHNSTON, C. E., assistant city engineer, Halifax, read a paper on the "Halifax Water Works." (See Transactions, vol. xii, pt. 1, p. 72). The subject was discussed by the PRESIDENT, PROFESSOR JACK, W. L. BISHOP, DR. A. H. MACKAY, T. V. HILL and DR. E. MACKAY; and a vote of thanks was presented to the lecturer.

Fourth Ordinary Meeting.

City Council Chamber, Halifax, 12th March, 1906.

The President, Mr. Doane, in the chair.

In the absence of the author, Dr. Poole read a paper by R. W. Ells, Ll. D., F. R. S. C., of the Geological Survey of Canada, on "The Oil-fields of Eastern Canada." (See Transactions, p. 598). Specimens illustrating the paper were shown from the collection of Dr. Poole. The paper was discussed by the President, and Drs. Woodman and Poole.

Fifth Ordinary Meeting.

City Council Chamber, Halifax, 9th April, 1906.

The President, Mr. Doane, in the chair.

Dr. Poole read a letter received by the curator of the Provincial Museum, from Laurence M. Lambe, of the Geological Survey of Canada, relative to amphibian-like remains found by Dr. Poole at the Joggins, Cumberland Co., N. S., and now in the Provincial Museum. The specimen, Mr. Lambe states, does not supply the information necessary for its determination.

Dr. Poole took the chair, while the President read a paper on "The Frost and Drought of 1905." (See Transactions, p. 623).

It was resolved that the question as to the desirability of having a self-recording rain-gauge placed by the meteorological department at Halifax, be referred to the council to take action if it sees fit.

Watson L. Bishop, superintendent of water works, Dartmouth, read a paper on "Eels in Water Pipes and Their Migration." (See Transactions, p. 640). The subject was discussed by the President, Dr. A. H. MacKay, R. H. Brown and H. Piers.

Dr. A. H. MacKay communicated a paper by Frank H. Reid, entitled, "Notes on Protective Colouring," which was discussed by Dr. MacKay, W. L. Bishop and H. Piers; and a vote of thanks was presented to Mr. Reid.

The following papers were read by title: "The Grignard Synthesis: Action of Phenyl Magnesium Bromide on Camphor," by H. JERMAIN M. CREIGHTON, Dartmouth, (see Transactions, p. 593); and "Contributions to the Study of Hydroxylamine," by G. M. JOHNSTONE MACKAY, B. A., Dartmouth, (see Transactions, vol. xi, pt. 2, p. 324).

SIXTH ORDINARY MEETING.

Room of Mining Society of N. S., Halifax, 21st May, 1906.

THE PRESIDENT, MR. DOANE, in the chair.

WATSON L. BISHOP, Dartmouth, brought to the notice of the Institute the occurrence of Star-nosed Moles (*C. cristata*) and a shrew in a submerged eel trap at the Dartmouth water-supply lake.

In the absence of the author, H. W. JOHNSTON read a paper by W. G. YORSTON, C. E., city engineer of Sydney, C. B., on "Water Powers of the Mersey River, Nova Scotia." (See Transactions, p. 651). The paper was discussed by the PRESIDENT, R. MCCOLL, A. A. HAYWARD, W. L. BISHOP, DR. H. H. READ, and DR. A. H. MACKAY.

RODERICK MCCOLL, C. E., provincial engineer, Halifax, presented a paper "On the Damage Done to Timber by *Toredo navalis* and *Limnoria lignorum*." The subject was discussed by the PRESIDENT, DR. A. H. MACKAY, W. L. BISHOP, and H. PIERS.

A. H. MACKAY, LL. D., F. R. S. C., superintendent of education, Halifax, presented a paper entitled, "Phenological Observations, Canada, 1905"; and also a paper on "Water-rolled Weedballs." (See Transactions, p. 667).

A vote of thanks was passed to PRESIDENT HAYWARD and the Mining Society of Nova Scotia for their courtesy in permitting the use of their room as a place of meeting.

HARRY PIERS,
Recording Secretary.

TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1905-1906

ON THE FLORA OF McNAB'S ISLAND, Halifax Harbour, N. S.: Part 1, General Notes; Part 2, Work in Special Orders; Part 3, Narcotisation of Plants; Part 4, Occasional Notes.—BY CAPTAIN JOHN H. BARBOUR, M. D., Royal Army Medical Corps.

(Read 13th. November, 1905.)

PART I.—GENERAL NOTES.

It is not my intention to deal fully with the flora of this island. I intend rather to just mention some of the principal things which struck me personally, leaving it to others who know the locality much better than I do, to fill in the details in after years, if this has not been already considerably done by observers in the neighbourhood of Halifax.

When we consider the position of the island, its size, the winters which occur, and the presence of the ocean around it, I think that we have on it a most wonderful variety of flowers, and the botanist may there find plenty of work to do in all departments, for he comes across woodland, littoral, meadow and sea plants growing in profusion within a small area.

One great peculiarity that one notices, is that the woodland plants descend right on to the shore, even to high-water mark,

and in fair numbers also. Never do I remember seeing so many woodland plants on one shore before, especially on the side of an island or district exposed to a good deal of the force, tides and winds of the Atlantic ocean, as is the case on the south side of the island looking out towards Devil's Island. Here at high tide one may cull raspberries with the water coming over one's boots, pick *Scutellaria* on the same spot, watch the milfoils growing in grand profusion and to a great height—as much as 3 to 4 feet or more. Then we have rock roses, not really littoral plants, everywhere, and at the proper season the margins are decked with masses of purple irises, so that one feels inclined to call the island " a garden of irises," for it is not only on the shore they are to be seen, but all over it. Grasses and sedges dip in the water and seem to enjoy the tide rippling over them. Other plants we find are rose-root, sea pea, sea rocket, sedum, asters, scarlet pimpernel, and the white nightshade, the evening primrose, and many more too numerous to mention. Another peculiarity which I noticed was the comparative poverty of the *Fucaceæ* on the shores, that is of species which find their habitat there. On the shore opposite Lawlor's Island, one meets with a couple or so of varieties of the *Melanophyceæ*. On the side towards the ocean opposite Devil's Island, it is about the same, a stray *Fucus vesiculosus* or *F. serratus* and *Laminaria;* while on the shores looking towards Halifax, practically none are to be seen. Along Meagher's Beach we do find various kinds of *Fucus, Florideæ*, etc., but nearly all these are washed up by the tides; few are settlers. Most shores exposed to the ocean are covered more or less with a sea-flora of a beautiful and varied character. The above flora generally appears to be that of brackish water rather than of the true sea type, or true fresh water one.

So far as the land flora generally is concerned, if I went into it in detail, it would occupy a paper by itself, therefore my remarks will of necessity be brief and general. Ferns are

numerous, but considering the nature of the island, a greater variety would have been expected, and that is by no means the case. Mosses are few in variety also, while among the *Equisetaceæ* there are several species. The *Coniferæ* are much as on the mainland, though the hemlock is very rare, and I found it only in one spot on the island.

Looking now for a moment on the Phanerogames of the island, it is curious to note the immense unmbers of beautiful violets, and a contrasting absence of their little allies, the wild pansies. I saw but one specimen of the *Hypercineæ*, which is peculiar, as they are very common on the mainland.

The island evidently is a veritable garden, in the season, for raspberries, and this brings me to suggest that it appears to me that McNab's Island might easily be converted to some good use as a spot wherein to grow various crops for economic purposes. Take, for instance, raspberries: the island is well suited for their production; they were very plentiful and of good size this last summer, wild as they are. With a little attention what quantities could be placed on the market in Halifax; there would be little or almost no train or transport rates to cut down the producer's results. Again, from the quantities or irises growing on it, the island is evidently well suited for the growing of them. Would it not be possible to manufacture a cheap and beautiful violet ink, stain, or dye from their rich, velvet perianths? I obtained some good purple writing fluid by a process of extraction from some this last summer, which had the property of darkening on exporsure to sun and rain. I had not time to complete my experiments, however, and the effect of time on the ink on paper can only be judged by how it will look in a year or two's time, and under various conditions of climate, etc., so that I do not intend to make public any results for the present.

Strawberries and blueberries run wild, and what I said about raspberries applies equally to the former. I think the island would also yield grasses for baskets, mats and such like

contrivances, though probably not in the same quantities as might be obtained easier from elsewhere.

The fungi of the island are very numerous and varied. Seldom, if ever, have I seen, certainly not in colour, so many *Basidiomycetes* and *Gastromycetes;* they are beautiful, too, in many instances.

Lichens also are abundant, but with neither of these did I have much to do. What notice I did take of the mushrooms will be referred to in my notes at the end of this paper.

These few general observations are all I wish to offer on the flora generally. I have looked at it from my own point of view, and though probably I have told you nothing new, possibly I have suggested a new light in which to consider it.

This brings me to Part II. of my subject, in which I deal with work specially done in one or two orders. The results may not appear large, but only a few plants can be dealt with carefully in a season. The work done is, as in a previous paper I read before the Institute a couple of years ago, mainly on variation.

PART II.—WORK IN SPECIAL ORDERS.

Primulaceæ.

Trientalis Americana. Star flower.—One of your commonest spring flowers. 500 specimens at least examined, and on that data results given. Variations in calyx and corolla practically none. In a few specimens one sepal was normally absent. It was in the stamens the variations occurred. In 77 specimens I found 7 stamens in each; in 167 specimens I found 8 stamens in each; in 205 specimens I found 6 stamens in each; and this latter number seems to be the most usual number of stamens present. In 17 specimens I found 5 stamens in each; in 34 specimens I found 4 stamens in each. It is curious to

notice, however, that while you had seven stamens present, often with eight petals; in the case of those with eight stamens the reverse did not hold good. Nearly always when eight stamens were present, eight petals and eight sepals were. Those in which the stamens were below seven, had petals and sepals usually normal, and no corresponding decrease in numbers.

Oxalidaceæ.

Oxalis acetosella. White wood-sorrel.—The number of specimens examined ran into hundreds, but I have lost the exact number. On going through a very large number I found so very little variation, so directed my attention to the descriptions of this plant in floras and compared them with what I noticed for myself, and I think that a modification of those descriptions is desirable, for they do not appear to be full enough or accurate enough in some respects, judging from the results I have obtained after examining at least four hundred or more plants.

The following is the flora's description:—Low herbs with an acid juice, and alternate compound leaves, the three leaves obcordate, and drooping in the evening; flowers long, heterogonus; sepals, obtuse; petals, pink, rarely white, veined with deep pink; capsule, subglobose, glabrous; seeds, ovoid, longitudinally grooved.

It is the petals which need a modified description:—Calyx and corolla regular. Petals, unequally divided apex, or as an alternate description, are unequally cordate. Petals may be white, but more usually they are tinted with purplish-pink, due to the ramifications of veins. The veins are of a darker purple-pink than are the petals, usually seven to eight in number, never more on each petal; they start from an orange-yellow corona situated close to the base of each petal.

The remaining description of the flower is an ample one, and does not appear to require to be changed.

Rubiaceæ.

Houstonia cœrulea. Bluets.—Quite one of the commonest earlier flowers of the season. 1500 specimens examined, mainly collected on McNab's Island, but some on the mainland in this instance.

There is not much variation in the outer whorls of the flower; flowers with six instead of four petals were met with in a couple of dozen instances, and four or five had as many as seven.

The one great variation I noticed was seen in the length of the style and the number of the stigmas. In the floras, the flower is described as having one style and two stigmas. Now I have found a heterogony of styles in these flowers. One variety has a long style with two stigmas; the second variety has a short style and most usually one stigma. The former I hold to be the one usually described in our books on flora.

The latter I have ventured to distinguish from it by giving it a new name—*Houstonia cœrulea var. Piersii*—after your esteemed secretary, Mr. H. Piers, who has aided me in so many ways in this kind of work.

The description, therefore, of the style in this new variety may be said to be as follows:—*Style*—Short, not longer than three-quarters, at most, of the length of the corolla tube. *Stigma*—Single nearly always, but two may be present which are partially united half way up their dorsal aspects.

This new variety I have found is based on the fact that practically one-third of the flowers examined presented these variations. They arise, too, not quite irregularly, for tufts of flowers occur in which all the flowers consist of one or other variety quite separate from those large patches where both kinds may be found indiscriminately.

Iridaceæ.

Iris versicolor. Blue flag.—Subject to little variation. 250 examined. The variations occurred in the flat, petaloid, arching stigmas. In 160, the stigmas possessed two irregular lobes at the apex, which may be considered to be what usually happens; 66 specimens had three lobes; 20 specimens had but one lobe. In four specimens I found one stigma absent, and in these the corresponding stamen was also absent.

Sisyrinchium angustifolium. Blue-eyed grass.—300 specimens examined. I have practically nothing new to add to what I said about this flower in a paper read before this society two years ago. I have not examined so many specimens of this plant this year as I did then, but the results work out the same. There was but one new feature I noticed, and that occurred only in six or eight specimens—it was the presence of little wings on the divisions of the perianth, one on each side.

A question was asked me at the time I read my last paper, which then I could not reply to. I now wish to say the cotyledons have nothing whatever to do with the variations observed; rather it is, as in *Iris versicolor* as well, a selective effort on the part of the flower to increase its surface area to attract certain insects more frequently and suitably, and it depends, I think, on that instinctive faculty, unconscious perhaps in a sense, which I believe animals and plants possess in common, though in varying degree, to reproduce more and more of their kind, even to the detriment of others, if not obtainable otherwise.

Caprifoliaceæ.

Linnæa borealis. Twin flower.—400 specimens examined. No variations worth noting were seen. This flower is one of the most regular plants I have ever examined, and its beauty is only enhanced by its modesty.

Ericaceæ.

Moneses uniflora. One-flowered pyrola.—This peculiar flower, which is the last I have to offer any special notes on, appealed to me much, on account of its prominent anthers, and the apparent want of conformity in the arrangement of its stamens; so much so, that I looked up different floras to see if I could find out what was the most usual arrangement of the whorl. I could not find anything on this subject, so I have undertaken to try and determine what is the most usual arrangement, and in this case, since I have a number of figures to deal with, I will say only that over 1,000 specimens were examined, and the following are the conclusions I arrived at:—(1) that the stamens are in one whorl; (2) the corolla may be complete or incomplete—that is, with five petals or less.

Considering now the flowers from the view that the stamens are ten or less, I want you to look at them as *regular* or *irregular*. Let us first consider the regular flowers:—

(*a*) Regular flowers, with corolla complete. By far the larger majority have the following arrangement of stamens in the whorl, 3, 2, 2, 2, 1. The next commonest is a variation on this, 3, 2, 2, 1, 2. Then come, some little way behind, another arrangement—3, 1, 2, 3, 1, and its variant, 3, 1, 3, 2, 1. Then in order we get 2, 2, 2, 2, 2, and far behind, and in only a few instances, comparatively speaking, 3, 2, 1, 1, 2, 1; 3, 3, 3, 1; 3, 1, 3, 1, 1, 2.

(*b*) Regular flowers with incomplete corolla.—The above arrangements hold good because only one or two flowers were met with in which the corolla was incomplete, and they possessed only four petals.

Let us now consider the irregular flowers:—

(*c*) Irregular flowers with corolla complete.—The usual arrangement was for one of the last pairs of stamens to be absent, if we consider the arrangement to be 3, 2, 2, 2, 1—

thus we get 3, 2, 2, 1, 1. Nine stamens, instead of ten. Next come those with only seven, and then those with eight.

(*d*) Irregular flowers with corolla incomplete.—The usual arrangement is one of eight stamens to four petals—2, 2, 1, 2, 1. Speaking generally, there is much variation in the arrangements among the irregular flowers, the following being the commonest:—

3, 2, 2, 1, 1. 3, 2, 2, 2. 3, 2, 1, 2, 1. 2, 2, 2, 1, 1, 1. 3, 1, 2, 3. 2, 2, 2, 2, 1.	9 stamens in the whorl.
3, 2, 2, 1. 3, 1, 1, 2, 1. 3, 2, 1, 2. 2, 2, 1, 2, 1.	8 stamens in the whorl.
2, 2, 2, 1. 3, 2, 2.	7 stamens in the whorl.
3, 1, 1, 1.	6 stamens in the whorl.

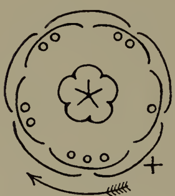
No other variants of any consequence noticed, so that these may be held to be the principal arrangements and numbers of stamens in the flowers.

In the irregular flowers with incomplete corollas, I wish to point out that the numbers of the petals present in the corolla weee usually four or five, and the sepals were decreased in a similar ratio. The carpellary leaves also were decreased in much the same manner.

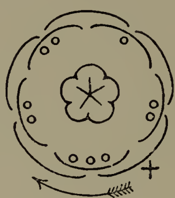
Having given the conclusions obtained, it will be necessary to show you practically how these results have been got at, how I started from a certain part of the whorl and went round it. Take the much more usual arrangement, 3, 2, 2, 2, 1. I always began with a three which I presumed to be on the side nearest to me, and passed round the whorl from right to left;

if I went the reverse way I would only get the above result reversed; but in all cases where three's were present I started to work from that number.

Look at these floral diagrams of flowers of the regular type with complete corollas. I passed round in the direction of the arrows from the spot marked by an x opposite a three.



3, 2, 2, 2, 1.
Fig. I.



3, 2, 2, 1, 2.
Fig. II.

3, 1, 2, 3, 1.
Fig. III.

3, 3, 3, 1.
Fig. IV.

Of course it was only by observation for a while previous to systematically proceeding, that I found the most suitable spot to start from. I did the same when a two came first.

While doing this special work, one or two other peculiarities were sometimes observed in the stigmas.

The stigma is usually described in books on flora as "large and peltate, with five narrow, acute, radiating lobes." In a certain number I noticed that the lobes were only four in number, and in about a dozen or more, the stigma itself as a whole assumed a claw-shaped form like that of a bird, and was sessile.

In conclusion, briefly reviewing the results of the staminal arrangements, let me say that in nearly half the specimens examined, 3, 2, 2, 2, 1 was the formula, and consequently it is the normal arrangement of the ten stamens present. Then came its variant, and the other formulæ make up the remainder.

PART III.—NARCOTISATION OF PLANTS.

This part of my paper consists of a few experiments made on wet days when outdoor work could not be well done. The plants used were mostly common ones found on the island, and chloroform was the narcotic used. In many cases several experiments were done with the same kind of plant. I do not claim that the results gained are as accurate as they might be, but looking over some works on physiology of plants, I can sav this, that certainly some of them are borne out as correct to a great extent; and remember, I was in camp with only rough contrivances to work with. I am satisfied myself with my results, but in any case I hope it may prove interesting to vou to hear them. I take the flowers used in no special order; will say what I did, briefly, and sum up results afterwards.

Moneses uniflora.—Specimens dry. Placed in lethal chamber entirely; that is, with only the air in the chamber. Narcotic given. Flowers changed in colour to light brown in two minutes; corolla, brown; anthers, untouched; carpels blackish, styles and stigma untouched. In half an hour all parts of flower dark brown.

Trientalis americana.—Specimens dry. Placed in chamber as in former case exactly. Little change in half an hour; flowers just a little flaccid.

Oxalis acetosella.—Specimen dry, and put into chamber as in previous specimens. Almost at once the leaves fell down and drooped; the petals of the flower curled back, instead of in, as in sleep, in ten minutes. The flower became limp, but colour remained unchanged. The leaves later opened again, but remained flaccid. Compare these results with normal sleep.

Specimens moistened with water and placed in the chamber. Effects less, leaves affected the most. Flowers became limp, but colour unchanged in ten minutes.

Moss.—Quite unaffected in ten minutes, or half an hour.

Cypripedium acaule.—Specimens dry when placed in chamber. Affected in five minutes; the other greenish lobes, the perianth, becoming discoloured and droop. Other effects proceed very slowly indeed, it taking two to three hours to bring results. Curious to say, the flowers transpired more or less under the influence of the narcotic, and the final result is difficult to obtain,—complete anæsthesia as it were.

Hieracium canadenis.—Specimens dry. Flowers began to be influenced in 15 minutes. Completely under influence in 20 minutes. Stems below the head absolutely limp, so that the flower head hung sharply down. The strap-like rays became dark yellow, but not closed as in sleep; they remained one-half to one-third open, and slightly curled on themselves. Another curious effect was observed in this plant, that when a specimen was placed dry, and just as it had been plucked, and not under the influence of the narcotic, in a chamber free from narcotic, but in which also was a narcotised orchid, this latter plant seemed to affect the hawkweed, which became drowsy and closed as in sleep, more or less.

Potentilla tormentosa.—Specimens used dry. In ten minutes the leaves were affected. The flowers closed in twenty minutes.

Drosera rotundifolia.—Specimens dry. In ten minutes leaves became flaccid and curled backwards. The tentacles became irregularly twisted and crossed. Recovery from influence took place if flower was placed in soil after a time, which was most unusual in those flowers I experimented upon.

Specimens moistened or wet. Flowers more tardy about coming under influence of the narcotic. At the end of fifteen minutes, slight discoloration, but no closing of flowers or drooping of the tentacles for fifteen minutes more, and then it was incomplete. Leaves behaved as in previous experiments. Here again the results differed from those obtained when ordinary stimuli are applied.

Onoclea sensibilis.—Fronds drooped in ten minutes. Pinnæ curled back.

Chrysanthemum leucanthemum.—Specimens dry. Heads began to droop in twenty minutes, when the root is present. Heads without root drooped and closed, leaves darkened and became limp in eight minutes.

Head with roots present, roots in lethal chamber completely, but head and leaves outside chamber in fresh air. Little affected. Leaves became slightly discolored, and flower just began to close in two hours.

Cornus canadensis.—Specimens dry. Very resistant. No effects in one hour. In one and a-half hours leaves just began to turn yellowish. In two hours quite yellow. These flowers sometimes transpire slightly under the influence of narcotic.

Trifolium pratense.—Specimens dry. Leaves affected in ten minutes, becoming nearly black, and limp. The flowers changed to purple from red in 28 minutes. Scent disappeared first and early, in five minutes. Changes completed in one hour.

Prunella vulgaris.—Specimens dry. Very rapidly affected. Flowers turned brown and became limp in five minutes or less. Leaves darkened. Results same, whether roots were present or not.

Iris versicolor.—Specimens dry. Flowers drooped in 15 minutes. Transpired slightly.

Sedum acris.—Affected in five minutes.

Sarracenia purpurea.—Specimens slightly moist and wet. Flowers affected in fifteen minutes, drooping. Discoloration slight. Leaves not affected for a longer time.

Ranunculus acris.—Specimens dry. Heads drooped and became a darker yellow in twenty minutes; leaves changed to a deep olive colour, and became limp in ten minutes. In specimens in which the roots were in lethal chamber and heads in fresh air, leaves closed in ten minutes, but were not discolored. The flowers were unaffected for a long time.

Taraxacum officinale.—Specimens dry. Flowers closed in ten minutes; closing complete.

Stellaria media and *Cerastium arvense.*—Specimens dry. In 25 minutes flowers began to droop and close slightly; leaves were unaffected. In 30 minutes flowers were closed completely. No discoloration of flowers or leaves.

Fragaria virginiana.—Specimens dry. Resistant. Only semi-narcotised in one hour.

Arctostaphylos uva-ursi.—Specimens dry. Influenced only slowly. Leaves discolored, but not limp, and flowers semi-closed in one hour. Specimens moistened, results the same.

Trifolium repens.—Specimens dry. Scent disappeared in seven minutes. Leaves drooped in ten minutes and became brown. In one hour the flower is seen to have its florets mostly lying with their apices pointed outwards instead of upwards as when fresh.

Habenaria lacera.—Specimens dry. Flaccid generally in ten minutes. Flowers brown in 15 minutes.—Specimens wet. Flaccid generally in 15 minutes. Flowers brown in half an hour.

Chrysanthemum leucanthemum and *Oxalis acetosella* were both placed with their leaves and flowers in air, but with their roots in chloroform fluid. In the case of the former, the chloroform seemed to act as a stimulant; the flowers thrived in it for 24 hours. In the latter, however, the leaves fell in ten minutes, and the flower drooped soon after. These were the only plants experimented with in this way.

The conclusions drawn from these few rough experiments were as follows, but they must not be considered conclusive, but rather as incentives to others to more accurately work up this physiological section:—

Conclusion I., is that some flowers are more sensitive to the influence of the narcotic than others, and in various degrees and times, even when removed from its direct influence.

II.—It is through the leaves, flowers and stem that this influence acts, more than by the roots, for often when applied to the latter, the results take longer to arrive at. Sometimes it even appears to act as a stimulant when applied directly to the roots.

III.—Colour is always affected practically, and purple flowers and leaves seem to be more influenced than a good many lighter ones.

IV.—In many instances, the results obtained are more or less the opposite to those seen when natural influences, such as wind, rain, heat or cold are applied. They are also the reverse of natural sleep.

V.—Some flowers transpire under the influence of a narcotic, and those which do most are the hardest to be affected.

VI.—Though I have not mentioned it in my experiments, flowers slightly under the influence of a narcotic may recover if removed from it; those deeply under it rarely, if ever, do.

VII.—Cell contents become altered. Granules may become disorganized or swell.

The practical reasons for my experiments are the same as so many others have done them for, and resolve themselves into three questions—What are the best flowers and plants for a town or house in and around which noxious chemical products are formed? Which are those least likely to be affected by soot, dust, harmful vapours, etc., containing narcotising elements? How may we still keep our towns and parks beautiful under such conditions? These simple experiments with wild flowers throw little light, I grant, on such things, but possibly one or two ideas may be gained, although similar experiments accurately conducted have often been done, which may be the stepping stones to greater efforts on the part of those who are interested in the beautifying of their native city, and who can teach those

in slum-land the simple methods of keeping in the way of thriving, their few window plants, possibly their only knowledge of the country beyond the city's outskirts.

Part IV.—Occasional Notes on Flora of McNab's Island.

Early fruit.—A ripe blackberry was found by me and eaten on July 20th, before I saw ripe raspberries.

Instances of similarity in colour and shape between various plants.—A couple of strawberry flowers which were found in different spots, but in both cases in the middle of a patch of *Oxalis acetosella,* had taken on the purple-white or pink colour of this latter flower, and both had only four petals. At a distance they were indistinguishable from the *Oxalis,* and it was only by chance, when picking these flowers, I noticed those of the strawberry.

Linnæa borealis I found quite white in the middle of bunchberries.

The *Basidiomycetes*, or mushrooms and toadstools of the island also in many instances seem to take on the colour of plants near which they grow; whether it is due to assimilation of colouring matter from such plants which can be quickly elaborated by these fast-growing fungi, or what is its special use I cannot say. For protection it cannot be; for fertilisation purposes it is very nearly unnecessary. As instances of what I mean I give the following, which I saw myself:

I saw a concolvulus flower trailing close to the ground; beside it was a toadstool, purple-red in colour, with a dirty white mottling as well, and a slight dimple on the upper surface of the pileus. The convolvulus flower was almost exactly the same in appearance, the white of the flower being dulled also. Moreover the opening of the tube of the corolla was so closed that one would say it was more like a fissure or dimple. At the first glance I thought both flower and toadstool were both the latter.

Another instance: I was passing some bunches or iris leaves, the veins of which are usually purplish in colour. Close to, in fact touching, them was a stump of what looked to be the remains of another bunch of leaves. I knocked it with my foot and found it was the stipe and partially unopened cap of a toadstool. The purple of the latter was exactly the same as the former.

So have I seen orange-yellow coloured ones growing close to the yellow loosestrife, bright red ones among the red bunch-berries, perfectly white ones near the Indian pipe, and so alike were they that they could not be distinguished till you were right upon them. Little, tiny white specks of toadstools among the moss, near where other little white flowers abound; variegated near where variation in many colours abound.

Of course many occur in situations quite independent of such conditions, but a certain number do find their habitat according to the above, and many other instances I have not noted.

A Catalogue of the Birds of Prince Edward Island.—By John MacSwain, Charlottetown, P. E. I.

(Read 13th November, 1905; revised to 1907.)

This catalogue of the birds of Prince Edward Island has been compiled chiefly from field notes, beginning in 1895 and continued to the present time. It contains the names of two hundred and three birds seen by the writer during this period of thirteen years; and a supplementary list of thirteen additional birds stated to occur in Prince Edward Island in the "Catalogue of Canadian Birds" by Prof. Macoun. There is a similar list of four species from "Birds of Prince Edward Island," by the late Mr. Francis Bain.

There are few works which make special reference to the birds of the Island. The most important is the interestingly written book of Mr. Bain just mentioned, which describes one hundred and fifty-two birds. It was published in 1891. Besides this, Mr. Bain, in his "Natural History of Prince Edward Island," devoted a section to the birds found here, and he wrote two or more magazine articles on the same subject. "Progress and Prospects of Prince Edward Island," 1861, by C. Birch Bagster, contains a list of forty-six birds. "A Manual of the Geography and Natural and Civil History of Prince Edward Island," 1861, by Rev. D. Sutherland, has a chapter on birds. These, with some articles which have appeared in the Island newspapers and "The Prince Edward Island Magazine," make up the ornithological literature of Prince Edward Island. Some tables on migration are appended to the catalogue.

The nomenclature is that of the American Ornithologists' Union "Check-List," and the numbers in parentheses refer to that work.

Order PYGOPODES.

Family PODICIPIDÆ.

1 (3). *Colymbus auritus* Linn. Horned Grebe.—Have seen one mounted specimen.

2 (6). *Podilymbus podiceps* (Linn.). Pied-billed Grebe. —Rare.

Family URINATORIDÆ.

3 (7). *Urinator imber* (Gunn.). Loon.—Not common, but frequently seen during summer. Breeds.

4 (11). *Urinator lumme* (Gunn.). Red-throated Loon. —Not seen as often as the preceding.

Family ALCIDÆ.

5 (27). *Cepphus grylle* (Linn.). Black Guillemot.—Captured occasionally. All that I have seen were in the mottled plumage. Breeds.

6 (30). *Uria troile* (Linn.). Murre.—Rarer than the Black Guillemot.

7 (34). *Alle alle* (Linn.). Dovekie; Little Auk.—More frequently seen than either the Black or Common Guillemot.

Order LONGIPENNES.

Family STERCORARIIDÆ.

8 (37). *Stercorarius parasiticus* (Linn.). Parasitic Jaeger. —Have seen one specimen only.

9 (40). *Rissa tridactyla* (Linn.). Kittiwake.—Common during summer.

10 (42). *Larus glaucus* Brunn. Glaucus Gull; Ice Gull. —Often seen in the autumn.

11 (45). *Larus kumlieni* Brewst. Kumlien's Gull.—Taken at Covehead, Oct. 7, 1905, and examined soon after it was taken to the taxidermist. It is now in the museum of the Academy, Truro, N. S. There are some ashy areas on some of the primaries of this specimen.

12 (47). *Larus marinus* Linn. Great Black-backed Gull.—Quite common spring and autumn.

13 (51). *Larus argentatus smithsonianus* Coues. American Herring Gull.—Common.

14 (54). *Larus delawarensis* Ord. Ring-billed Gull.—Have seen one only.

15 (60). *Larus philadelphia* (Ord.). Bonaparte's Gull.—Common.

16 (64). *Sterna tschegrava* Lepech. Caspian Tern.—One was shot at Tracadie Bay, May 13th, 1905.

17 (70). *Sterna hirundo* Linn. Common Tern.—Commonest of the terns seen here.

18 (71). *Sterna paradisæa* Brunn. Arctic Tern.—Not common.

Order TUBINARES.

Family PROCELLARIIDÆ.

19 (94). *Puffinus filiginosus* (Strickland). Sooty Shearwater.—Very rare. One was mounted by Calder in 1904.

20 (104). *Procellaria pelagica* Linn. Stormy Petrel.—One was stuffed by Calder and sent to the museum of the Truro Academy in the autumn of 1905. Two were blown ashore on the north coast of the Island during the great November gales of 1906, and were brought to Mr. Calder.

21 (109). *Oceanites oceanicus* (Kuhl.). Wilson's Petrel.—Occasionally found on north coast of the Island.

Order STEGANOPODES.

Family SULIDÆ.

22 (117). *Sula bassana* (Linn.). Gannet.—Not uncommon. Saw one on St. Peter's Bay, July 7th, 1905.

Family PHALACROCORACIDÆ.

23 (119). *Phalacrocorax carbo* (Linn.). Cormorant.—A few may be seen every summer.

24 (120). *Phalacrocorax dilophus* (Swainson). Double-crested Cormorant.—Rarer than the preceding.

Order ANSERES.

Family ANATIDÆ.

25 (129). *Merganser americanus* (Cass.). American Merganser; Goosander.—Occasionally seen.

26 (130). *Merganser serrator* (Linn.).—Red-breasted Merganser. Common.

27 (132). *Anas boschas* Linn. Mallard.—Rare.

28 (133). *Anas obscura* Gmelin. Black Duck.—The commonest of our ducks. Breeds here.

29 (135). *Anas strepera* Linn. Gadwell.—Very rare.

30 (139). *Anas carolinensis* Gmelin. Green-winged Teal.—Frequently seen.

31 (140). *Anas discors* Linn. Blue-winged Teal.—Rarer than the Green-winged Teal.

32 (143). *Dafila acuta* (Linn.). Pintail.—Not uncommon.

33 (144). *Aix sponsa* (Linn.). Wood Duck.—Very rare indeed. Have seen none for some years. Saw one in 1893.

34 (148). *Aythya marila nearctica* Stejn.—American Scaup Duck. A rare spring and fall migrant.

35 (149). *Aythya affinis* (Eyt.). Lesser Scaup Duck.—No commoner than the larger scaup.

36 (151). *Glaucionetta clangula americana* (Bonap.). American Golden-eye.—Common in autumn. Breeds.

37 (152). *Glaucionetta islandica* (Gmel.). Barrow's Golden-eye.—Have seen two only. These were shot at St. Peter's Bay in the spring of 1904.

38 (153). *Charitonetta albeola* (Linn.). Bufflehead.—Rarely seen in early spring.

39 (154). *Clangula hyemalis* (Linn.). Old Squaw; Long-tailed Duck; Cockawie.—Often seen with Golden-eyes in early spring.

40 (160). *Somateria dresseri* Sharpe. American Eider.—I have seen but two specimens; mounted by Mr. Calder.

41 (163). *Oidemia americana* Swainson. American Scoter.—Rare.

42 (165). *Oidemia deglandi* Bonap. White-winged Scoter.—Sometimes seen on the northern coast.

43 (166). *Oidemia perspicillata* (Linn.). Surf Scoter; Sea Coot.—Seen in autumn.

44 (167). *Erismatura rubida* (Wils.). Ruddy Duck.—One mounted specimen seen, Oct. 14th, 1904. Very rare.

45 (171*a*) *Anser albifrons gambeli* (Hartl.). American White-fronted Goose.—On Oct. 21st saw a young goose, afterwards mounted, which corresponded in size and color with the description of the young of this species.

46 (172). *Branta canadensis* (Linn.). Canada Goose; Wild Goose.—Common during migration, spring and autumn.

47 (172*a*). *Branta canadensis hutchinsii* (Swains. & Rich.). Hutchins's Goose.—Occasionally with flocks of *B. canadensis*.

48 (173). *Branta bernicla* (Linn.). Brant.—Arrives in large flocks soon after the breaking up of the ice in spring and leave for the north early in June.

49 (180). *Olor columbianus* (Ord.). Whistling Swan.—One was shot at Wheatley River, October, 1885. This specimen was mounted and is now in the possession of Judge McDonald.

Order HERODIONES.

Family ARDEIDÆ.

50 (190). *Botaurus lentiginosus* (Montag.). American Bittern.—Not common.

51 (194). *Ardea herodias* Linn. Great Blue Heron — Quite common. Seen in numbers at ebb-tide along the borders of rivers. Breeds.

52 (202). *Nycticorax nycticorax nævius* (Bodd.). Black-crowned Night Heron.—Very rare. A young specimen was shot in the marshes at Mount Stewart by a Charlottetwn sportsman, and examined by me at Mr. Calder's.

Order PALUDICOLÆ.

Family GRUIDÆ.

53 (205). *Grus canadensis* (Linn.). Little Brown Crane. —Accidental. A young specimen was shot at Earnscliffe, Oct. 23, 1905. I examined it at Mr. Calder's. Length 30.50 in., wing 18 in., bill 2.75 in. Plumage dark gray, tipped with light brown or bronze; feathers of head brown or chestnut. On May 22, 1899, I saw a mounted specimen of this bird exhibited in Mr. Watson's drugstore.

Family RALLIDÆ.

54 (212). *Rallus virginianus* Linn. Virginia Rail.— Saw a stuffed specimen which was collected by Mr. W. Earle at Tignish, where they are occasionally seen. Mr. Earle also shot one at Belle River, and it is now in his collection.

55 (214). *Porzana carolina* (Linn.). Sora; Carolina Rail.—Collected by Mr. Earle at Tignish, and now in his possession. Two were shot at Wisener's Mills on Oct. 4, 1906, by Mr. Frank E. Johnson of Yonkers, N. Y.

56 (221). *Fulica americana* Gmel. American Coot.—Not common, but is occasionally seen in the low grounds bordering

streams. A specimen was taken and mounted by Bryenton, who sold it afterwards to Calder. Though rare, the Coot, or "Mud-hen" as it is called, is well known to sportsmen here.

ORDER LIMICOLÆ.

FAMILY SCOLOPACIDÆ.

57 (228). *Philohela minor* (Gruel.). American Woodcock. —Once common, but now rare. It arrives here in early spring, sometimes in March. Soon afterwards it builds its nest and rears its young.

58 (230). *Gallinago delicata* (Ord.). Wilson's Snipe.—Scarcely exceeds the Woodcock in number. Breeds.

59 (234). *Tringa canutus* Linn. Robin Snipe.—Shot at Alexandra by J. H. Judson, 24th September, 1905, and mounted by Calder.

60 (235). *Tringa maritima* Brunn. Purple Sandpiper. --Saw one at Calder's, which was shot at St. Peter's Island, Feb. 6th, 1901.

61 (239). *Tringa maculata* Viell. Pectoral Sandpiper; "Jack Snipe."—Four of these birds were in the market, Charlottetown, on Sept. 27, 1907. I do not remember to have noted this species before.

62 (240). *Tringa fuscicollis* Vieill. White-rumped Sandpiper.—A few spring and autumn migrants.

63 (242). *Tringa minutilla* Vieill. Least Sandpiper.—Common.

64 (246). *Ereunetes pusillus* (Linn.). Semipalmated Sandpiper.—Common during the summer.

65 (248). *Calidris arenaria* (Linn.). Sanderling.—Common migrant.

66 (251). *Limosa hæmastica* (Linn.). Hudsonian Godwit. —This species has become very rare. One specimen was taken at Alberton and forwarded to Mr. Earle, who handed it

to Mr. Calder to be mounted. I have seen but two of these birds.

67 (254). *Totanus melanoleucus* (Gmel.). Greater Yellow-legs.—Often seen along the sea beach in spring and autumn.

68 (255). *Totanus flavipes* (Gmel.). Yellow-legs.—Rather rarer than the Greater Yellow-legs.

69 (256). *Totanus solitarius* (Wilson). Solitary Sandpiper.—A few pass the summer and rear their young on the borders of inland ponds.

70 (258). *Symphemia semipalmata* (Gmel.). Willet.—Rare.

71 (263). *Actitis macularia* (Linn.). Spotted Sandpiper.—Common. Nests in border of woods or sometimes in a grain field. Breeds.

72 (264). *Numenius longirostris* Wils. Long-billed Curlew.—Rare.

73 (265). *Numenius hudsonicus* Lath. Hudsonian Curlew.—A not uncommon summer visitor.

74 (266). *Numenius borealis* (Forst.). Eskimo Curlew.—Commonest of the three curlews.

Family CHARADRIIDÆ.

75 (270). *Charadrius squatarola* (Linn.). Black-bellied Plover; Beetle-head.—Seen in flocks of the Golden Plover.

76 (272). *Charadrius dominicus* Mull. American Golden Plover. Once quite common; now rare.

77 (273). *Ægialitis vocifera* (Linn.). Kildeer.—Very rare.

78 (274). *Ægialitis semipalmata* Bonap. Semipalmated Plover; Ring-neck Plover.—Not uncommon.

79 (277). *Ægialitis meloda* (Ord.). Piping Plover.—Common. Saw four on Souris beach, July 6th, 1905. Breeds.

Family APHRIZIDÆ.

80 (283). *Arenaria interpres* (Linn.). Turnstone.—Not uncommon.

ORDER GALLINÆ.

FAMILY TETRAONIDÆ.

81 (298). *Dendragapus canadensis* (Linn.). Canada Grouse. —I have never seen the Canada Grouse anywhere here. Some elderly sportsmen who claim to know the difference between this and the Ruffed Grouse, state that it was not uncommon not many years ago. Now it is probably extinct in Prince Edward Island.

82 (300*a*). *Bonasa umbellus togata* (Linn.). Canadian Ruffed Grouse.—Rare a few years ago, but lately, owing to a better game law, it is increasing in number. Breeds.

ORDER COLUMBÆ.

FAMILY COLUMBIDÆ

83 (315). *Ectopistes migratorius* (Linn.). Passenger Pigeon. —At one time seen in large flocks; the last seen was in 1857.

84 (316). *Zenaidura macroura* (Linn.). Mourning Dove. —Taken at Alexandra, Sept. 22, 1905, by F. H. Judson, and mounted by Calder.

ORDER RAPTORES.

FAMILY FALCONIDÆ.

85 (331). *Circus hudsonius* (Linn.). Marsh Hawk.— Common. Breeds.

86 (332). *Accipter velox* (Wils.). Sharp-shinned Hawk.— Not uncommon. Breeds.

87 (333). *Accipiter cooperi* (Bonap.). Cooper's Hawk.— Rare. This and the Sharp-shinned are our most destructive hawks and are usually the raiders of poultry yards.

88 (334). *Accipiter atricapillus* (Wils.). American Goshawk.—An occasional winter visitor.

89 (337). *Buteo borealis* (Gmel.). Red-tailed Hawk.— Common in the more wooded parts of the country where it breeds.

90 (347*a*). *Archibuteo lagopus sancti-johannis* (Gmel.). American Rough-legged Hawk.—Have seen but one winter specimen.

91 (352). *Haliæetus leucocephalus* (Linn.). Bald Eagle; White-headed Eagle.—Very rare visitor. There is a mounted specimen in the hall of the Provincial Building. Three were seen by me about a mile north of Souris on July 5th, 1906.

92 (354*b*). *Falco rusticolus obsoletus* (Ridg.). Black Gyrfalcon.—One was captured near Southport, November 7th, 1904.

93 (356). *Falco peregrinus anatum* (Bonap.). Duck Hawk.—A young specimen was secured at Lowther's Point on October 3, 1906, by Mr. Frank E. Johnson of Yonkers, N. Y.

94 (357). *Falco columbarius* Linn. Pigeon Hawk.—Rare, but found breeding.

95 (360). *Falco sparverius* Linn. American Sparrow Hawk.—Rare. Breeds.

96 (364). *Pandion haliaetus carolinensis* (Gmel.). American Osprey; Fish Hawk.—Not common.

Family BUBONIDÆ.

97 (366). *Asio wilsonianus* (Less.). American Long-eared Owl.—Very rare; one on October 14th, 1904.

98 (367). *Asio accipitrinus* (Pall.). Short-eared Owl.—Commoner than the preceding.

99 (368). *Syrnium nebulosum* (Forst.). Barred Owl.—Though not abundant, it is both a summer and winter resident.

100 (371). *Nyctala tengmalmi richardsoni* (Bonap.). Richardson's Owl.—One was shot in a barn at Alexandra and was brought to Calder to be mounted, December 26, 1905.

101 (372). *Nyctala acadica* (Gmel.). Saw-whet Owl; Acadian Owl.—Resident and not rare. Several specimen were collected near Pownal, 1904.

102 (373). *Megascops asio* (Linn.). Screech Owl. I have seen one only.

103 (375). *Bubo virginianus* (Gmel.). Great Horned Owl.—This and *S. nebulosum* are our commonest owls. Breeds.

104 (375*a*). *Bubo virginianus subarcticus* (Hoy). Western Horned Owl.—One, the only one I have seen, was brought to Calder to be stuffed in February, 1906.

105 (376). *Nyctea nyctea* (Linn.). Snowy Owl.—An irregular winter visitor. A great many were noted in the winter of 1905-6.

106 (377*a*). *Surnia ulula caparoch* (Mull.). American Hawk Owl.—Rare. There are two mounted specimens in the Provincial Building.

ORDER COCCYGES.

FAMILY CUCULIDÆ.

107 (387). *Coccyzus americanus* (Linn.). Yellow-billed Cuckoo.—One was shot by Bryenton at Brackley Point. It is now in the museum of the Natural History Society, Charlottetown.

108 (388). *Coccyzus erythrophthalmus* (Wils.). Black-billed Cuckoo.—Rare.

FAMILY ALCEDINIDÆ.

109 (390). *Ceryle alcyon* (Linn.). Belted Kingfisher.—A common summer resident. Breeds, making its tunnelled nests in river banks.

ORDER PICI.

FAMILY PICIDÆ.

110 (393*a*). *Dryobates villosus leucomelas* (Bodd.). Northern Hairy Woodpecker.—Resident summer and winter. Breeds.

111 (394). *Dryobates pubescens medianus* (Swains.). Downy Woodpecker.—Commoner than the Hairy Woodpecker. Seen at all times in the year. Breeds.

112 (400). *Picoides arcticus* (Swains). Arctic Three-toed Woodpecker.—A rare winter visitor.

113 (401). *Picoides americanus* Brehm. American Three-toed Woodpecker.—Rarer even than the preceding.

114 (402). *Sphyrapicus varius* (Linn.). Yellow-bellied Sapsucker.—Rare; but several were collected in May, 1904.

115 (405*a*). *Ceophlœus pileatus abieticola* Bangs. Northern Pileated Woodpecker.—Becoming rarer as the forests disappear. A mounted specimen is in the Provincial Building.

116 (412*a*). *Colaptes auratus luteus* Bangs. Northern Flicker; Yellow-hammer.—A common summer resident. Breeds.

Order MACROCHIRES.

Family CAPRIMULGIDÆ.

117 (420). *Chordeiles virginianus* (Gmel.). Nighthawk.—Commonly known as the "Mosquito Hawk." A common summer resident. Breeds. Bird on two eggs found on the gravelled roof of Prince Street School, June 15th, 1905.

Family MICROPODIDÆ.

118 (423). *Chætura pelagica* (Linn.). Chimney Swift.—Apparently not so common as they were some years ago. Breeds.

Family TROCHILIDÆ.

119 (428). *Trochilus colubris* (Linn.). Ruby-throated Hummingbird.—A not uncommon summer resident. Breeds.

Order PASSERES.

Family TYRANNIDÆ.

120 (444). *Tyrannus tyrannus* (Linn.). Kingbird.—Common summer resident. Breeds.

121 (456). *Sayornis phœbe* (Lath.). Phœbe.—Rare. Breeds.

122 (459). *Contopus borealis* (Swains.). Olive-sided Flycatcher.—Common. Breeds.

123 (461). *Contopus virens* (Linn.). Wood Pewee.—Not rare. Breeds.

124 (463). *Empidonax flaviventris* Baird. Yellow-bellied Flycatcher.—Very rare; one only seen.

125 (466*a*). *Empidonax pusillus traillii* (Aud.). Traill's Flycatcher.—Very rarely seen.

126 (467). *Empidonax minimus* Baird. Least Flycatcher.—Occasional.

Family ALAUDIDÆ.

127 (474). *Otocoris alpestris* (Linn.). Horned Lark.—Seen in migration in early spring and autumn. Sometimes with Snow-buntings.

Family CORVIDÆ.

128 (477). *Cyanocitta cristata* (Linn.). Blue Jay.—Common in summer and winter. Breeds.

129 (484). *Perisoreus canadensis* (Linn.). Canada Jay.—Common many years ago, now quite rare. Breeds.

130 (486*a*). *Corvus corax principalis* Ridg. Northern Raven.—Accidental. Two were shot at Montague, March, 1904.

131 (488). *Corvus americanus* Aud. American Crow.—Very common; resident. Not so many remain throughout the winter. Breeds.

Family ICTERIDÆ.

132 (492). *Dolichonyx oryzivorus* (Linn.). Bobolink.—A rare summer visitor.

133 (498). *Agelaius phœniceus phœniceus* (Linn.). Red-winged Blackbird.—Two specimens were seen by Prof. Macoun at Covehead, July, 1888. Two pairs of these birds were in this place, Covehead, in July, 1905. Breeds.

134 (501). *Sturnella magna* (Linn.). Meadow-lark.—Have seen but one specimen, collected by Mr. Earle in Western Prince County, where it is occasionally seen. It is in Mr. Earle's collection,

135 (507). *Icterus galbula* (Linn.). Baltimore Oriole.—One pair was seen by Prof. Macoun near Brackley Point, and a specimen was taken at Tignish.

136 (509). *Scolecophagus carolinensis* (Mull.). Rusty Blackbird.—Not rare. Breeds.

137 (511*b*). *Quiscalus quiscala æneus* (Ridg.). Bronzed Grackle.—Common within the last three years. Nests near the city.

FAMILY FRINGILLIDÆ.

138 (515). *Pinicola enucleator* (Linn.). Pine Grosbeak.—Some winters common; others, not seen.

139 (517). *Carpodacus purpureus* (Gmel.). Purple Finch.—Common within the last few years. Breeds.

140 (—). *Passer domesticus* (Linn.). European House Sparrow.—A rather too common resident. First seen in Charlottetown in November, 1886. Breeds.

141 (521). *Loxia curvirostra minor* (Brehm). American Crossbill.—Not uncommon.

142 (522). *Loxia leucoptera* Gmel. White-winged Crossbill.—Less frequent than American Crossbill.

143 (528). *Acanthis linaria* (Linn.). Redpoll.—A rare spring visitor.

144 (529). *Spinus tristis* (Linn.). American Goldfinch.—A summer resident. Common for the last few years. Breeds.

145 (533). *Spinus pinus* (Wils.) Pine Siskin; Pine Finch.—Not so common now as they were a few years ago.

146 (534). *Plectrophenax nivalis* (Linn.). Snowflake; Snow Bunting; Snowbird.—Flocks are often seen in late autumn and winter.

147 (540). *Poocætes gramineus* (Gmel.). Vesper Sparrow; Grass Finch.—Local in distribution, not abundant in any locality.

148 (542*a*). *Ammodramus sandwichensis savanna* (Wils.). Savanna Sparrow.—A few may be found in any locality. Breeds.

149 (549*b*). *Ammodramus caudacutus subvirgatus* Dwight. Acadian Sharp-tailed Sparrow.—Rare. A few have been seen on the marshes along the Hillsborough River.

150 (550). *Ammodramus maritimus* (Wils.). Seaside Sparrow.—Very rare.

151 (554). *Zonotrichia leucophrys* (Forst.). White-crowned Sparrow.—Found in a few localities.

152 (558). *Zonotrichia albicollis* (Gmel.). White-throated Sparrow; Kennedy Bird.—A common summer resident. Breeds.

153 (559). *Spizella monticola* (Gmel.). Tree Sparrow.—A few seen during the spring migration.

154 (560). *Spizella socialis* (Wils.). Chipping Sparrow.—Common. A summer resident. Breeds.

155 (563). *Spizella pusilla* (Wils.). Field Sparrow.—I have seen this bird only on three occasions. Breeds.

156 (567). *Junco hyemalis* (Linn.). Junco.—Common. Found everywhere. Breeds.

157 (581). *Melospiza fasciata* (Gmel.). Song Sparrow.—This is our earliest, and next to the Junco, our most abundant sparrow. Breeds.

158 (584). *Melospiza georgiana* (Lath.). Swamp Sparrow.—A rare summer resident. Breeds.

159 (585). *Passerella iliaca* (Merr.). Fox Sparrow.—A few are seen on their way north and south.

160 (587). *Pipilo erythrophthalmus* (Linn.). Towhee; Chewink.—Very rare. Saw a few on Malpeque Road in 1900.

161 (595). *Habia ludoviciana* (Linn.). Rose-breasted Grosbeak.—Uncommon. All that I have seen have been taken near Bradalbane.

162 (604). *Spiza americana* (Gmel.). Dickcissel; Black-throated Bunting.—Very rare. One mounted specimen seen.

Family HIRUNDINIDÆ.

163 (612). *Petrochelidon lunifrons* (Say). Cliff Swallow; Eave Swallow.—Not so common since the advent of the House Sparrow. The latter has in some places taken possession of the nesting places of the swallow. Breeds.

164 (613). *Chelidon erythrogaster* (Bodd.). Barn Swallow. —A common summer resident, breeding chiefly in barns.

165 (614). *Tachycineta bicolor* (Vieill.). Tree Swallow.—Not so common as our other species of swallows. Arrives about the same time. Breeds.

166 (616). *Clivicola riparia* (Linn.). Bank Swallow.—Nests in high banks of St. Peter's Island and other suitable places along the coast.

Family AMPELIDÆ.

167 (619). *Ampelus cedrorum* (Vieill.). Cedar Waxwing. —A not uncommon summer resident; nests in August.

Family LANIIDÆ.

168 (621). *Lanius borealis* Vieill. Northern Shrike; Butcher-bird.—A rare winter visitor.

169 (622). *Lanius ludovicianus* (Linn.). Loggerhead Shrike.—Rarer even than the preceding.

Family VIREONIDÆ.

170 (624). *Vireo olivaceus* (Linn.). Red-eyed Vireo.—Not common. Breeds.

171 (627). *Vireo gilvus* (Vieill.). Warbling Vireo.—In spring small flocks are sometimes seen on their way northward. The specimen I examined was shot by Bryenton at Brackley Point.

172 (631). *Vireo flavifrons* Vieill. Yellow-breasted Vireo.—More numerous than the Red or White-eyed Vireo.

173 (631). *Vireo noveboracensis* Gmel. White-eyed Vireo. —Not common.

Family MNIOTILTIDÆ.

174 (636). *Mniotilta varia* (Linn.). Black and White Warbler.—Rare.

175 (642). *Helminthophila chrysoptera* (Linn.). Golden-winged Warbler.—One was seen on June 5th, 1897.

176 (645). *Helminthophila ruficapilla* (Wils.). Nashville Warbler,—Not common. Have seen two at Mermaid, south of Hillsboro.

177 (647). *Helminthophila peregrina* (Wils.). Tennessee Warbler.—Saw three of these warblers in June, 1900. Have seen no others.

178 (648). *Compsothlypis americana* (Linn.). Parula Warbler.—Not common.

179 (650). *Dendroica tigrina* (Gmel.). Cape May Warbler. —One only has come under my notice. It was in a spruce grove near Charlottetown, September 2nd, 1899.

180 (652). *Dendroica æstiva* (Gmel.). Yellow Warbler. — Common; often builds its nest in a lilac bush in the city.

181 (655). *Dendroica coronata* (Linn.). Myrtle Warbler. —Common. The first to arrive and the most numerous of our warblers. Breeds.

182 (657). *Dendroica maculosa* (Gmel.). Magnolia Warbler.—Rare. More frequently seen a few years ago than now. Breeds.

183 (660). *Dendroica castanea* (Wils.). Bay-breasted Warbler.—Rare. There is a mounted specimen in the Provincial Building.

184 (661). *Dendroica striata* (Forst.). Black-poll Warbler. —Had seen one only up to 1905. Saw a second one on June 16th, 1905.

185 (662). *Dendroica blackburniæ* (Gmel.). Blackburnian Warbler.—Very few of this beautiful species have been seen here.

186 (667). *Dendroica virens* (Gmel.). Black-throated Green Warbler.—Common. Have seen it several years in succession in different localities. Breeds.

187 (671). *Dendroica vigorsii* (Aud.). Pine Warbler.—Have seen it two summers in succession some years ago, not since.

188 (674). *Seiurus aurocapillus* (Linn.). Oven-bird.—Not common. Seen twice, different years, at Mermaid. Breeds.

189 (679). *Geothlypis philadelphia* (Wils.). Mourning Warbler.—Rare.

190 (681). *Geothlypis trichas* (Linn.). Maryland Yellow-throat.—Not common. Found always in low swampy thickets. Breeds.

191 (687). *Setophaga ruticilla* (Linn.). American Redstart.—A common summer resident. Breeds.

Family MOTACILLIDÆ.

192 (697). *Anthus pensilvanicus* (Lath.). American Pipit.—Saw one that was shot out of a flock of five at Pownal, January, 1904.

Family TROGLODYTIDÆ.

193 (722). *Troglodytes hiemalis* Vieill. Winter Wren.—Uncommon. A few are found in the eastern parts of the Island. Breeds.

Family CERTHIIDÆ.

194 (726). *Certhia familiaris americana* (Bonap.). Brown Creeper.—Rarely seen here.

Family PARIDÆ.

195 (727). *Sitta carolinensis* Lath. White-breasted Nuthatch.—Common in some localities. Breeds.

196 (728). *Sitta canadensis* (Linn.). Red-breasted Nuthatch.—Commoner than the white-breasted species and more widely distributed. Breeds.

197 (735). *Parus atricapillus* (Linn.). Black-capped Chickadee.—Common summer and winter. Breeds.

198 (740). *Parus hudsonicus* Forst. Hudsonian Chickadee.—Not as common as the Black-capped Chickadee. Breeds.

Family SYLVIIDÆ.

199 (748). *Regulus satrapa* Licht. Golden-crowned Kinglet.—Uncommon. Breeds.

200 (749). *Regulus calendula* (Linn.). Ruby-crowned Kinglet.—Quite rare. Breeds.

Family TURDIDÆ.

201 (756). *Turdus fuscescens* Steph. Wilson's Thrush; Veery.—An uncommon spring visitor.

202 (759*b*). *Turdus aonalaschkœ pallasii* (Cab.). Hermit Thrush.—Not common. A summer resident. Breeds.

203 (761). *Merula migratoria* (Linn.). American Robin. —A numerous summer resident. An occasional one passes the winter here. Breeds.

Species Reported by Other Writers.

From Professor Macoun's "Catalogue of Canadian Birds."

In Professor Macoun's "Catalogue of Canadian Birds" there are thirteen additional species, the names of which I have inserted here, with notes of their occurrence as given in that catalogue:

1 (2). *Colymbus holbœlii* (Reinh.). Holbœll's Grebe; Red-necked Grebe.—Large flocks seen on P. E. I., August 8th, 1888 Macoun).

2. (214). *Porzana carolina* (Linn.). Sora; Carolina Rail. —Breeding in P. E. I. (Macoun.)

3 (549. 1*a*). *Ammodramus nelsoni subvirgatus* (Dwight). Acadian Sharp-tailed Finch.—A few birds on the salt marshes at Tignish, P. E. I., were the only ones I could discover (Dwight).

4 (583). *Melospiza lincolni* (Aud.). Lincoln's Sparrow.—A pair was found breeding at Brackley Point, P. E. I., June 26th, 1888 (Macoun).

5 (611). *Progne subis* (Linn.). Purple Martin.—A few pairs breeding at Brackley Point, P. E. I., June, 1888 (Macoun.)

6 (629). *Vireo solitarius* (Wils.). Blue-headed Vireo.—Seen at Hunter River, July, 1888 (Macoun).

7 (654). *Dendroica cœrulescens* (Gmel.). Black-throated Blue Warbler.—A few were detected at Souris (Dwight).

8 (672*a*). *Dendroica palmarum hypochrysea* Ridg. Yellow Palm Warbler.—An incubating female taken at Tignish (Dwight).

9 (675). *Seiurus novaboracensis* (Gmel.). Water Thrush.—A few individuals were met with at Tignish (Dwight).

10 (685). *Wilsonia pusilla* (Bonap.). Wilson's Warbler.—One specimen was secured at Tignish in an arbor-vitæ and alder swamp (Dwight).

11 (686). *Wilsonia canadensis* (Linn.). Canadian Warbler.—Rather common about Tignish, but not met with elsewhere (Dwight).

12 (704). *Galeoscoptes carolinensis* (Linn.). Catbird.—A few specimens were seen at Stewart's Mill in July, 1888 (Macoun).

13 (758*a*). *Turdus ustulatus swainsonii* (Cab.). Olive-backed Thrush.—Taken at Covehead Road, July 5th, 1888 (Macoun).

From Francis Bain's "Birds of Prince Edward Island."

1 (106). *Oceanodroma leucorhoa* (Vieill.). Leach's Petrel.—Occasionally blown ashore during storms (Bain).

2 (169*a*). *Chen hyperborea nivalis* (Forst.). Greater Snow Goose.—Individuals of the White or Snow Goose appear in the flocks of Wild Geese early in the season (Bain).

3 (261). *Bartramia longicauda* (Bechst.). Bartramian Sandpiper; Field Plover.—The Bartramian Sandpiper is with us in September and October, and in great numbers falls before the sportsman's deadly piece (Bain).

4 (349). *Aquila chrysaetos* (Linn.). Golden Eagle.—The Golden Eagle visits us sometimes (Bain).

Migration.

This table gives the dates of arrival in the neighborhood of Charlottetown of six birds as given in the reports of phenological observations made by the writer from 1895 to 1905.

I.

	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Song Sparrow........	Ap 7	Ap 11	Ap 9	Mar19	Ap 8	Ap 14	Ap 14	Mar31	Mar28	Mar27	Mar31
American Robin	Ap 13	Ap 12	Ap 12	Ap 3	Ap 6	Ap 14	Ap 16	Ap 3	Mar26	Mar30	Mar31
Junco	Ap 13	Ap 11	Ap 16	Ap 3	Ap 22	Ap 21	Ap 15	Ap 2	Ap 6	Mar30	Ap 6
Swallows	May12	May17	May20	My 15	May20	May24	May24	May14	May25	May 5	May13
Night Hawk	Jly 22	Jne 28	Jne 11	May27	Jne 4	Jne 5	Jne 1	May23	Jne 13	May28	Jne 11
Canada Goose........	Mar17	Ap 8	Mar27	Mar14	Mar31	Mar20	Mar18	Mar 3	Mar16	Mar 9	Mar22

Table No. 2 gives approximately the times of coming of a few sparrows, warblers and other birds. It does not assume to give exact dates; as no special effort was made to ascertain the times of arrival.

II.

	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Savanna Sparrow. ...	May19	May 3	.....	.....	May24	May24	May17	......	......	......	.....
White-throat Sparrow	May19	May 9	May 7	May22	May14	......	......	May18	May12	......	May13
Chipping Sparrow...	......	......	......	......	......	May24	......	......	May10	May28	Jne 4
Yellow Warbler	May25	.....	......	......	.....	May28	......	......	......	May28	......
Magnolia Warbler....	......	......	May29	......	Jly 14	Jne 3	Jly 17	......	......	......	......
Blackburnian Warbler	......	......	......	......	Jne 29 May27	......	May19	......	......	......	......
Black & White Warbler	......	......	......	......	Jne 17	.....	.....	......	Jny 25	.... .	......
Myrtle Warbler	......	......	......	......	......	May17	May 7	May18	May12	May 9	May23
Maryland Y'll'w-throat	......	......	......	......	......	Jne 27	......	Jne 30	......	......	Jne 4
Redstart	.....	May25	Jne 12	......	May27	......	......	......	Jne 10	Jne 25	May31
Black-throated Green Warbler	......	......	......	......	......	......	May24 Jne 2	......	May25	......	Jne 26
Brant	Ap 27	Oct 10	Ap 19	......	Ap 29	Ap 17	......	......	......	......	Ap 26
Kingbird	May25	....	......	......	......	Jne 3	......	......	......	Jne 1	Jne 4

The following table gives some of the dates when the birds named therein were seen. It indicates the time when they may be expected to be found here :

III.

	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Black-cap'd Chickadee	......	......	......	......	May24 Aug 9	......	Jly 31 Nov 7	Ap 2 Dec 28	May10	......	......
American Bittern	......	......	......	......	......	May24	......	......	......	Nov25	Jly 7 Jly 30
Great Blue Heron....	......	......	......	......	......	Aug18	Jly 31	......	......	Ap 7	Jly 7 Jly 10
Semipalmated Plover.	......	......	......	......	......	Aug18	......	......	Sep 3	Sep 1	......
Belted Kingfisher	......	......	......	......	......	......	......	Jne 8	May17	Mar 5	Jly 7 Jly 17
Flicker	......	May 9	May 4	......	May14	May17	May 1	......	May11 Oct 21	......	Ap 20
Phœbe	......	......	......	Mar19	Mar 5 Jne 2	May24	......	......	......	May28	Jne 4 Jly 20
Olive-sided Flycatcher	......	......	......	......	Jne 12 Aug 9	......	......	......	......	......	Jly 20
Purple Finch	.....	......	......	....	......	......	......	May 3	May11	Jne 25	May12 May23
Redpoll.............	......	Ap 11	Mar18	......		......	......	Ap 13	.....	......	......
American Goldfinch..	.....	......	Jne 12	......	.....	......	May36	Jne 30	May27	......	Aug 1
Cedar Waxwing......	....	.....	......	.....	......	Jne 21	Oct 22	......	Oct 21	.....	Aug10

The Grignard Synthesis: The Action of Phenyl Magnesium Bromide on Camphor.*—By H. Jermain M. Creighton, Dalhousie University, Halifax, N. S.

(Read April 9th, 1906.)

As is well known, the organo-metallic compounds have long been used in a great many organic syntheses, as for instance, in the synthesis of the hydrocarbons and the ketones, to take two examples at random. In all these reactions the yields have always been small, and most of the methods complicated, roundabout and unsatisfactory.

By means of the so-called "Grignard reaction" these difficulties have been done away with, the syntheses of a great many compounds effected, and many new compounds prepared.

Compounds of the hydrocarbons with magnesium have long been known, but it was not until recently (1900) that Grignard investigated their action toward different organic compounds.

Grignard found that when methyl iodide was allowed to react with many organic compounds in the presence of magnesium, a vigorous reaction took place and a new compound was formed. When the air was not excluded the mixture took fire. He saw from the variety of ways in which the reaction could be employed that magnesium was likely to make the compounds of zinc and sodium with organic radicles of secondary importance in organic syntheses. Moreover, the reaction should be expected to be more complete with magnesium than with zinc, because magnesium is much more electro positive.

It has been found when an organo-magnesium halide is allowed to act on an aldehyde, or ketone, and the reaction pro-

* Contributions from the Science Laboratories of Dalhousie University (Chemistry).

duct decomposed with water, that secondary and tertiary alcohols are formed respectively, the reactions taking place in accordance with these equations:—

I.

$$R'MgX + RCHO = RCH\left\langle\begin{matrix}OMgX\\ R'\end{matrix}\right.$$

$$RCH\left\langle\begin{matrix}OMgX\\ R'\end{matrix}\right. + H_2O = RC\left\langle\begin{matrix}OH\\ R'\end{matrix}\right. + Mg(OH)_2 + HX$$

II.

$$R'MgX + R\text{–}CO\text{–}R'' = RC\left\langle\begin{matrix}OMgX\\ R''\\ R'\end{matrix}\right.$$

$$RC\left\langle\begin{matrix}OMgX\\ R''\\ R'\end{matrix}\right. + H_2O = \left.\begin{matrix}R\\ R'\end{matrix}\right\rangle C\left\langle\begin{matrix}OH\\ R''\end{matrix}\right. + Mg(OH)_2 + HX$$

In these reactions the double linking of the oxygen of the aldehyde or ketone is broken, and one of the free bonds of the oxygen unites with hydrogen to form hydroxyl, while the free carbon bond takes up a hydrocarbon residue.

Japan camphor $C_{10}H_{16}O$ contains the ketone group $C{=}O$; under the influence of an organo-magnesium compound, it should therefore form a tertiary alcohol. Zelinsky,[1] who has done a great deal of work on the preparation of cyclic alcohols, found that when camphor is treated with magnesium methyl iodide, and the reaction product decomposed with water, there is obtained a tertiary alcohol whose composition is expressed by the formula $C_{11}H_{20}O$.[2]

No work having been done on the action of organo-magnesium halides of the aromatic series on ketones, it was decided to investigate the action of magnesiumphenylbromide on Japan camphor.

Experimental.

32 g. of phenyl bromide dissolved in $1\frac{1}{2}$ times its weight of ether, was allowed to drop slowly on the calculated amount,

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[1] Ber. d deut. chem. Ges , 1901, 34, 2877.
[2] Ibid.

4.8 g., of cleaned magnesium ribbon contained in a round bottomed flask, to which was fitted a reflux condenser. It is most essential that the magnesium ribbon be perfectly free from oxide. When about $\frac{1}{3}$ of the halide had been added, the flask became warm and a vigorous reaction set in, making it necessary to cool the flask with running water, lest too great heat should cause decomposition.

The calculated amount (17 g.) of camphor, the camphor and halide reacting molecule for molecule, was dissolved in $1\frac{1}{2}$ times its weight of ether and allowed to drop slowly into the magnesium halide. This compound was contained in a round-bottomed flask fitted with a return condenser. The mixture was kept at 60°C. The contents of the flask were allowed to stand over night, the reaction being a gradual one. Next morning the mixture was poured on crushed ice, containing a small excess of dilute hydrochloric acid to dissolve the precipitated $Mg(OH)_2$, and the new product separated out as an oily yellow liquid. These equations illustrate the reactions taking place:—

$$C_6H_5MgBr + C_9H_{16}C{=}O = C_9H_{16}C\begin{cases} OMgBr \\ C_6H_5 \end{cases}$$

$$C_9H_{16}C\begin{cases} OMgBr \\ C_6H_5 \end{cases} + 2H_2O = C_9H_{16}C\begin{cases} OH \\ C_6H_5 \end{cases} + Mg(OH_2) + HBr$$

The oil was separated from the rest of the mixture and shaken up five times with sodium acid sulphite to remove any ketone that had not been acted upon. It was then washed with water to remove the sodium acid sulphite and dehydrated over calcium chloride.

The oil was then heated in a distilling flask, and at 205-210°C. a vapour was given off, which on cooling, solidified in the condenser to a white mass. This proved to be camphor. The flask was allowed to cool and the contents heated in vacuo, a pale yellow oil distilling over at 150°C.

The yield was nearly ten grams, about twenty-five per cent. of the theoretical yield. As has been mentioned above, the action between the ketone and halide is a gradual one; the small yield and the large quantity of uncombined camphor are probably due to the mixture not having been allowed to stand sufficiently long.

This new alcohol is a pale yellow oil, with a balsam-like taste. It is miscible with alcohol, ether and chloroform. Its specific gravity is 0.977.

The boiling point of this oil is 143°-145°C. at 14 mm. pressure and 258°-260° at 760mm.

Molecular Weight.

Its molecular weight was determined by the Victor Meyer method.

I. The vapour 0.0600g of substance displaced 6.6 cc. air at 715mm. and 19°C giving Mol. Wt. 231.9

II. " " 0.0620 " " displaced 6.8 cc. air at 715mm. and 19°C giving Mol. Wt. 232.6

Mean Molecular Weight, 232.1
Calculated for $C_{16}H_{22}O$, 230.17

Analysis.

Two analyses of the oil were made, but owing to an accident one was a failure, and there was not enough oil to make a third.

0 2510 g of substance :	0 7722 CO_2	0.2 83 H_2O
giving	83.89% C	9.28% H
calculated for $C_{16}H_{22}O$	83.42% C	9.63% H

Specific Rotation.

The specific rotation was determined, but owing to the thickness and colour of the liquid only a small quantity could be used. Consequently the deflection of the plane of polarisation was very small, less than one degree, and the percentage error probably as great as 5%.

The specific rotation $(\alpha)_D$ in alcohol solution was found to be 7°.55′.

The foregoing results show that the compound obtained by the action of magnesiumphenylbromide on Japan camphor is a tertiary alcohol,whose composition is expressed by the formula,

$$C_{10}H_{16}\left\langle\begin{matrix} OH \\ C_6H_5 \end{matrix}\right.$$

This is analogous to the tertiary alcohol,

$$\text{methyl borneol; } C_{10}H_{16}\left\langle\begin{matrix} OH \\ CH_3 \end{matrix}\right.$$

prepared by Zelinsky, and should therefore be called phenyl borneol.

Dalhousie University, Halifax,
April 1st, 1906.

The Oil-fields of Eastern Canada.— By R. W. Ells, LL.D., F. R. S. C., Geological Survey of Canada, Ottawa.

(Read 12th March, 1906.)

The occurrence of petroleum or rock-oil has been known from a very early date in the world's history. It is referred to frequently in Holy Writ under such names as slime or pitch, in connection with the building of the city of Babylon, the construction of the ark, the preparation of the cradle of Moses, etc. It was found in considerable quantity in the valley of the Dead sea, whence it was transported to Egypt and to the ports on the Mediterranean, where it was extensively employed in ship-building, as well as by the Egyptians and other nations in the embalming of the dead. Many references to this substance are also found in the works of profane writers, more especially of Herodotus, Plutarch, and Josephus; while the ancient sect of Guebers or Fire-worshippers of Persia apparently derived the visible symbol of their religion from the oil-springs and accompanying natural gas of the Baku district, now in southern Russia, but till within the last 200 years a part of the Persian empire; or from similar occurrences in other parts of Persia and in India, in both of which countries the presence of this substance has been known for many centuries. In some places also, as in China and Japan, natural gas, which is frequently an accompaniment of petroleum, has been used for a long period for both heating and lighting purposes.

In certain parts of Europe where petroleum occurs in the form of springs it has long been used medicinally, and has been regarded as a valuable remedy for rheumatism and other kindred diseases. So also in the early history of Canada and the northern States, crude petroleum, under such names as Seneca and British oil, was extensively employed for various

ailments and commanded quite a large price, the material being obtained from the natural springs which are found in western Ontario and southern New York or Pennsylvania adjacent to the south.

Petroleum or rock-oil is in fact a substance of almost world-wide occurrence. It has been found in nearly every country in Europe and Asia; in some of the islands of the Pacific and Indian oceans; in New Zealand and Australia, and in North and South America. It is especially abundant in the United States and in Canada, occurring in many places from the Atlantic to the Pacific. It has been asserted by some authority that in its distribution it is only surpassed by water itself, but whether this statement can be maintained or not, it may safely be said that petroleum in some form is one of the most widely known of mineral substances to-day.

Its wide range in distribution over the earth's surface is only equalled by its extended geological occurrence, since in some one of its many forms it has been found in most of the formations or systems from the earliest Laurentian to the latest Tertiary. The result of the study of this material within the last thirty years has been to do away very largely with the old theory that rock-oil was practically confined to rocks of Devonian and Upper Silurian horizons. In face, some of the largest known deposits at the present day are found in the newest rock-formations, while other very large oil-fields have their location in rocks of Trenton age. In so far as the geological horizons are concerned therefore, it would seem in the present state of our knowledge, to be a difficult matter to predicate just where petroleum or some one of its related substances may or may not be found. A safer test as regards deposits capable of economic development would appear to be connected with the geological conditions which prevail in the special field to be exploited.

Petroleum, in the form of crude oil, is doubtless one of the most important of the bituminous compounds. Several other var-

ieties are, however, found, among which may be mentioned anthraxolite, asphalt, ozokerite, albertite, manjak, etc. Petroleum can also be obtained in large quantities from certain rock formations which abound in bitumen, such as the Utica shales of Ontario and Quebec, the Albert shale of New Brunswick, the stellarite of the coal areas in Pictou, and various other formations found in widely diverse portions of the globe. In a number of cases these formations have been extensively utilized as a source of supply for petroleum, as in the case of the bituminous shales of Scotland, France and elsewhere, while in Canada in the early years of the industry, quite extensive plants were erected in Ontario for the distillation of the Utica shale, and in New Brunswick of the Albert shale deposits. Unfortunately for these industries the discovery of the great reservoirs of crude petroleum in the United States and in western Canada (Ontario) speedily reduced the price of the raw material so that its further extraction from the shales became unprofitable, and this industry was long since abandoned.

The mineral anthraxolite, appears to be to all intents merely a hardened or thickened petroleum, and has been found in rocks as low down as the Laurentian and Huronian, where it occurs in vein form in granitic or associated rocks in Ontario; in slates of lower Cambrian or Huronian age west of Sudbury, at Chelmsford; and in the Black river limestone associated with baryte near Kingston. In Quebec it has been found in veins traversing slate and quartzite of lower Cambrian age in Labrador; and in irregular deposits in slates of the Sillery and Lévis formations near the city of Quebec. It is very probable that future examinations may reveal its presence elsewhere in these old rocks. In some places, as near Chelmsford, the quantity is considerable, and, if sufficiently pure, might be worked, but the large percentage of ash in its composition interferes with its utilization as a suitable fuel for domestic or steam purposes. At one time great hopes were

entertained by certain persons that Ontario had at last obtained a fuel supply peculiarly its own, and it is to be regretted that these expectations have not yet been realized. So also at Quebec it was at one time anticipated that workable deposits might be obtained, the mineral found at this place giving fairly satisfactory results as a fuel. It was, however, found, on attempting development, to be confined to mere strings and pockets of no commercial importance.

The presence of these carbon compounds in rocks of great antiquity would, on the hypothesis that all these substances, including graphite, are of organic origin, carry the life history of the globe to a very remote period. While it is no doubt true that organic remains are found as far back in time as the early Cambrian period, and in some of these older rocks are abundantly displayed, crude petroleum in workable quantity has not yet been found therein. Moreover, the presence of petroleum and its kindred minerals in rocks of igneous origin, such as basalts and various diorites, where there is no indication of sedimentary rocks or traces of organic life opens up another aspect of the question that should receive careful consideration. In this connection it may be stated that petroleum in some of its forms occurs in greenstone and basalt, hornblende rocks, augite, feldspar, etc., at various places both in Europe and America. It is found in the Laurentian, both in Scotland and Canada; in melaphyre at several places; in the granite of Cornwall, England; and in trap rocks both in the province of Quebec at Gaspé, in connection with Devonian slates, and on the west coast of the Queen Charlotte islands in basalts of Tertiary age.

In so far as the petroleum deposits of economic importance occur on this continent it may be said, generally speaking, that in the eastern or Atlantic division these are confined to Silurian, Devonian and Carboniferous rocks, while in the western or Pacific division they belong to formations of Cretaceous and Tertiary age.

The various geological formations in which crude petroleum is found in various parts of the world may be briefly stated. Thus in the Baku district of southern Russia, where probably the largest and most productive wells are situated, the associated rocks are somewhat incoherent sandstones of recent Tertiary age, so incoherent, in fact, that the oil which outflows in immense quantities contains a large percentage of sand which has to be separated after collecting the oil. In India, Burmah, Assam, Beloochistan, Persia, Japan and China, oil is found in workable quantity in rocks of the same general horizon or from some portion of the Tertiary formations, wherever the conditions are favourable to its occurrence. Of these an interesting feature is seen in the oil wells of Beloochistan, where, owing to the disturbed and faulted character of the strata, attempts to obtain the minerals in paying quantities have proved a failure.

In the group of islands comprising Borneo, Java, Sumatra and Timor, as well as in the Phillipines, the oil-bearing rocks are also of Tertiary age, and this is likewise the case with the deposits of New Zealand and of Australia.

In the South American states it occurs in rocks of practically the same horizon, as well as in Mexico and in the islands of Barbados and Trinidad; while along the west coast of United States, from Texas on the south to Alaska on the north, as also in territory bordering the east side of Rocky mountains, in oil-fields of Colorado and in Alberta, the containing formations range from the Cretaceous into the Tertiary. In Canada on the Pacific coast no oil-wells have yet been reported, but traces of oil have recently been found in connection with the Tertiary sandstone and shale of one of the interior coal basins. On the east slope of the mountains, however, borings have been carried on for several years in connection with oil springs which are supposed to issue from Cretaceous rocks, while the great deposits of tar sands which occur along the Athabasca and

upper Peace rivers, in the district north of Edmonton, also belong to the same horizon. The recent flows of natural gas which have been struck at Calgary and at Medicine Hat in the country of the plains, are also from strata of Cretaceous age.

In Europe it is also of interest to note that the oil-wells, in so far as these are at present productive, belong to recent rather than to Palæozic times. Thus in Italy petroleum is found in Tertiary sediments along anticlines which follow generally the trend of the Appennines; in Germany in the Tertiary in part and partly in the underlying Jurassic; while in Great Britain, France, Spain, and Switzerland, in Europe, and in Algeria and Egypt in Africa; it occurs also in rocks pertaining to the Cretaceous and Tertiary formations.

It will be seen, therefore, that in the greatest number of petroleum producing countries the mineral is obtained from formations which are quite recent as regards the geological scale. Coming nearer home, however, we find, as a rule, that petroleum pertains rather to rocks of Palæozoic age. In Canada these have usually been assigned to the Devonian system, since it was long supposed that it was from these formations that the wells derive their flow of oil; but in the United States some of the most productive wells are sunk in formations as far down as the Trenton. On this continent, therefore, there appears to be a marked line of separation as regards the horizon of both coal and petroleum, between the occurrences east of a line defined by the Mississippi river for the United States side of the boundary, and by the eastern edge of the prairie country in Canada which divides the deposits of Palæozoic age on the east from those of Cretaceous and Tertiary age on the west.

In character also petroleum varies greatly in different districts. It ranges from a highly fluid condition and a light colour in some areas, to a thick and exceedingly dark coloured substance in others; the specific gravity of the mineral, according to observations made by Boverton Redwood, having a

proportionally wide range, extending from 0.771 to 1.020. As a rule, the lighter oils yield a larger percentage of kerosene than the heavier grades. Comparing the oils of western Ontario with those from the celebrated wells found in the United States it is found that the Canadian product has a somewhat greater specific gravity, while tests made on the oils taken from the wells in Gaspé during the borings some years ago, gave sometimes a still higher specific gravity. The oils of western Ontario have also a more offensive odor than many of those to the south, due presumably to the presence of sulphur.

In colour, native oils range from a light yellow to a black or brownish-black, and often with shades of green. In regard to density this is measured by what is known as the Baumé scale, in which the lower the grade on Baumé the higher the specific gravity of the oil; thus, 10 degrees Baumé is equivalent to specific gravity 1.000, while 90 Baumé is the equivalent of an oil with specific gravity 0.6363.

Turning now to the consideration of the conditions under which petroleum in economic quantity is usually obtained, it will be observed that the general arrangement of the rock formation is a very important factor, whether the locality be underlaid by rocks of the older or the newer horizons; and this feature is sometimes lost sight of in search for new oil-fields. For not only must the rocks in which the oil is supposed to occur lie in a nearly horizontal attitude, or in the form of low swelling anticlines but the oil itself must be kept in by an impervious covering of shale or some other rock. If in the case of a rock series, which is supposed to carry oil in greater or less amount, this covering is broken or faulted or the rocks, as a whole, are more or less tilted and disturbed, it is probable that the cementing cover is quite unequal to holding down the underlying oil, which will therefore in some way tend to find an outlet to the surface, and will have been lost in ages long since past. It is, therefore, evidently unwise, to say the least,

to waste much time or capital in an attempt to obtain oil in quantity from an area where the rock formations are much disturbed. In several such cases small quantities of petroleum have indeed been obtained, sufficient for the time to lead the explorer to invest additional sums of money, though the final outcome, as might have been expected, has generally been disastrous.

On the hypothesis now generally accepted, oils have originated from the decomposition of animal or vegetable organisms which have been buried during the process of rock formation precisely as we see going along our sea shore at the present day, where shells, seaweeds, fish, etc., are buried by the accession of sands or other materials which are moved by tidal currents or by wind action.

These decomposed organisms, with their resulting carbon contents, were supposed by Dr. T. S. Hunt to be the actual source from which petroleum was derived, and the resulting oil to form a part of the formation in which they are deposited, preferably in limestone, since their remains were easily recognized and were often observed to be highly charged with oily matter in the several strata encountered. He, therefore, contended that petroleum originated from the primary decomposition of organic matter and pertained to the stratum in which the organisms were first laid down. Another school, however, contended that the original source of the petroleum was in some lower stratum, and that the oil resulting from the decomposition of organic matter, as well as the accompanying gases, rose or percolated through underlying sediments till they encountered a non-pervious layer, being assisted in this upward movement by the action of percolating waters at a greater underlying depth.

On this latter theory the oils of the Petrolia district, which may be taken as an example of the general principle, have originated at some lower horizon than that in which they are

now found by boring, and have ascended gradually till they have met the porous dolomite of Devonian age in which they now seem to occur. They were held in place by the overlying cover of grey shales which succeeds the limestone, and which by the drillers is usually called "soapstone". and by this impervious cover, under great pressure, are hermetically sealed till the overlying rock is pierced, when they make their escape to the surface with tremendous force. The strata throughout the Ontario oil district lie in an almost horizontal position or in gentle anticlines so low that the dip of the beds is scarcely perceptible to ordinary measurements.

To go into elaborate details as to causes and effects would, however, swell the present paper to too great lengths. They can be well studied by reference to the excellent report by Dr. Orton on the "Occurrence of Petroleum, etc., in Kentucky," and in other bulletins of a special nature relating to the subject.

While rock-oil and natural gas are widely distributed throughout the Dominion of Canada, and while attempts to work many of these deposits have been made at a number of places from time to time, it is to be regretted that in many cases such efforts have been usually attended with a lack of fruitful results. Much of this unnecessary expenditure could have been avoided had due attention been given to the geological features of the several areas which have been tested.

In so far as boring investigations for oil are concerned in Canada it must be confessed that up to the present the original field in south-west Ontario has been the only one that has given satisfactory results. It is, however, confidently expected that at some future time portions of the great Cretaceous plain east of the Rocky mountains, in which large supplies of natural gas are now being developed, will be found to be also oil-producing; but this is still matter for future investigation. It may, however, be stated that the Pierre shales, in which the oils of the Florence basin in Colorado occur, have an extensive development in the Canadian north-west.

In the Atlantic provinces of Canada explorations for petroleum have been carried on at intervals for many years, in Nova Scotia, New Brunswick and Quebec as well as in Newfoundland. So far only negative results have been obtained, but a study of the several fields in which operations have been conducted will present some features of general interest.

In contrast with the oil-fields of western Ontario or of the eastern States, in both which areas the oil-bearing rocks lie in nearly horizontal layers, either of sandstone, limestone or shale, the rocks of the eastern areas in Canada are more or less disturbed, being thrown into folds with their accompanying faults and dislocations.

Although the island of Newfoundland is not politically a part of Canada, geologically speaking its oil-fields are related and may be considered in this place. Of these there are at present but two in which operations have been carried on, viz., at Port au Port bay, north of St. George's bay, and on the west coast further north, at Parson's pond.

In the article on petroleum published in the Annual Bulletin of the United States Geological Survey, these occurences are assigned to Cambrian rocks. The reason for this is not very clear, for during a visit to the former locality, several years ago, a brief study was made of the district by the writer which led to very different conclusions.

The two principal geological formations found around the shores of Port au Port bay from the Gravels east and west, are 1st., a series of fossiliferous limestones of the Lévis or Calciferous formation, a part of the old Quebec group of Canada, and 2nd., an unconformably overlying series of fossiliferous shales and limestones of Lower Carboniferous and Upper Devonian age, portions of which are faulted down into the Calciferous division which forms prominent ridges along the shores of the bay. Towards the inner end of the long point, on which the borings are situat-

ed, these Carboniferous rocks occupy the shore for some distance and extend for several miles out to the end of the point itself, though concealed in part by peat deposits, in which distance they also appear to include portions of an underlying series of Devonian shales. On the eastern side of the bay, where borings have also been made, the sales and sandstone are again exposed, and include bands of bituminous shale, which exactly resemble certain bands in the Albert shale series of New Brunswick. The shales on both sides of the bay are much disturbed, with numerous faults and dislocations, and in places contain remains of plants. It is in this series of rocks that the oil-wells of Long point have been sunk, as well as those on the east shore already referred to.

While indications of petroleum are seen at several places along the beach in the form of oozings or small springs, and while it was found in small quantity in several of the bore-holes, the amount thus obtained was in all cases unimportant from the economic standpoint, and the geological conditions were such as to warrant the conclusion that the expenditure of further capital in the locality was not advisable. Similar conditions apparently exist at Parson's pond to the north, where the oil-bearing rocks are apparently of the same horizon, judging from the statements published on the work done in that district, and are affected by a like series of folds and breaks as at Port au Port. The results of the borings at this place are apparently quite similar to those already described, the oil occurring in small quantity, while the geological conditions appear to be equally unfavourable as at Long point. The geological horizon of these deposits, therefore, instead of belonging to the Cambrian is assignable to the Devonian or lowest part of the Carboniferous, probably the former.

Crossing the Gulf of St. Lawrence to the Gaspé peninsula, in the province of Quebec, we reach another oil-field which has been known for half a century, and in the exploitation of which

very large sums of money have been spent in a vain attempt to find petroleum in paying quantity. More than fifty years ago Sir William Logan recognized the existence of oil-springs in this district, and they were described in his earliest reports as situated in places sometimes near the shore and sometimes inland. Attempts were made as far back as 1866 by a boring located near one of these springs to find the source from which the outflow was derived, and the boring reached the depth of nearly 700 feet. Here a small quantity of oil was reported, but owing to the loss of the boring tools the hole was abandoned, the occurrence of oil being apparently insufficient to warrant further expenditure at that time. Subsequently the Petroleum Oil Trust began an extensive series of borings in 1889, which were carried on for nearly fifteen years, and in connection with the Canada Petroleum company, an area extending inland for some thirty miles and with a breadth of six to ten miles, was very thoroughly explored by boring, several of the holes being sunk in close proximity to the original location near the spring already referred to. In all, more than fifty holes were bored, some of which reached a depth of over 3700 feet. The results of all these borings have been collected and were given to the public in a report by the writer to the Geological Survey Department in 1902. An interesting fact was disclosed in the several borings made at the original site, in that, though a depth of over 2400 feet was reached no oil was found beyond mere traces; the rocks are highly inclined at this place, and there is probably a line of fault and an anticline in the vicinity.

The rocks of this district belong to the Devonian system, of which a section aggregating 7000 feet is exposed along the eastern Gaspé shore. Generally speaking, these rocks are inclined at high angles, in some places reaching sixty to eighty degrees. Faults are seen at several places, and intrusive dykes of diabase also occur, one of which of large size at Tar point is remarkable for containing petroleum, sometimes as a solid, but

generally in liquid form, disseminated through the igneous rock in drusy cavities, some of which are lined with chalcedony.

The area is also traversed by well defined anticlines, running generally in an east and west direction; and in several places these are affected by fault lines. It is near these lines of fault that most of the oil-springs are situated.

As might be anticipated from a close study of these rocks conditions favourable to the occurrence of oil in quantity are absent, owing, in large part, to their usually highly inclined character and to their broken condition. In fact, the area if it ever contained petroleum in quantity, of which, however, there is no particular indication, would have been deprived of its stores long since by escape along these lines of fracture. Be that as it may, it has been clearly demonstrated by the expenditure of large sums of money and by the sinking of numerous wells to great depths, that with but few exceptions, the rocks passed through are now practically barren as regards oil. In some of the wells it would appear that there is a small amount of oil which finds its way into the bore-holes, probably by seepage from the surrounding strata, which can be obtained by pumping, but in most of the holes bored there was evidently no trace of oil whatever, though from a number water is still flowing freely.

The results obtained in this area, as in Newfoundland, tend to strengthen the theory, already well proved in the western oil-fields, that productive wells in eastern Canada must be sought for in rocks which are comparatively undisturbed, and preferably with low anticlinal dips, and while the records of the wells bored in the Gaspé district show in several cases the occurrence of oil, aggregating an output of some hundred of barrels, the general principle laid down is still maintained.

In the province of Quebec no other occurrences of petroleum are as yet recorded, the bituminous matter found at Lévis in the form of anthraxolite, and in Labrador being excepted.

In the flat country lying east of Lake St. Peter, which is an expansion of the St. Lawrence between Montreal and Quebec, boring operations have been carried on for more than twenty years, some of the holes being sunk to depths of more than 1000 feet. The rocks of the district in which the borings have been made belong to the Lorraine and Medina formations, which lie in a comparatively flat basin extending across the St. Lawrence westward. Though natural gas in considerable quantity has been found, this has not yet assumed large commercial importance, but no petroleum has yet been met with.

In Nova Scotia, rocks supposed to be oil-bearing occur at several places. Probably the most important area of these is found in Cape Breton on the shores of Lake Ainslie, where attempts have been made for a number of years to find petroleum in quantity by boring. Here, as in Gaspé, the indications of rock-oil are observed in the form of springs and oozings, which escape from shales along the lake shore.

The rocks consist of shales and sandstone, generally of grey or greenish shades, which contain plant stems and fucoids. They have been classed provisionally as Lower Carboniferous, but as they clearly underlie the lowest known rocks of this formation it would seem more fitting to include them, on stratigraphical evidence, as a part of the Devonian series. They correspond closely in character and position with those rocks which are regarded as of the Devonian age elsewhere in this province and in New Brunswick.

Attempts to obtain oil by boring were commenced on the east side of this lake half a century ago; but though many holes have been put down, some of which reached a depth of 3000 feet, these have as yet been unsuccessful in finding oil in quantity. As in Gaspé and elsewhere, the strata are usually much broken up and inclined at high angles, with a well marked faulted structure in places. This feature is pointed out by Dr. I. C. White, of Virginia, in his report on the probable oc-

currence of oil in this distrct, where he says "the area of the field is so limited and the dip of the strata so high that there is hardly a chance of its being obtained here in large enough quantity to pay for its development." The area has apparently been fairly well proved in depth, and it would appear that any petroleum that may at one tme have been present in these rocks has long since passed off along the lines of fracture.

On the south side of Minas basin, at Cheverie, and on the Avon river, near Hantsport, borings for oil have been carried on during the last three years. Along the Avon, below Hantsport, a considerable thickness of shale and sandstone, with occasional beds of limestone, outcrops. These are regarded as the equivalent in age of the celebrated Albert shales of New Brunswick, though the percentage of bituminous matter is much less in the Avon, or, as they are usually styled, the "Horton series". Though for many years regarded as a portion of the Lower Carboniferous formations they are now considered as belonging to the Devonian system; since they uncomformably underlie the lowest known Lower Carboniferous rocks in this province.

These shales extend eastward from the Avon to the south side of Cobequid bay, and at Cheverie underlie a considerable thickness of gypsiferous rocks also associated with sandstone and shales. In the borings which have been made at this place the drill passed through these gypsiferous strata and entered a series of shales, etc., which were supposed to be a part of the oil-bearing series. In the underlying rocks indications of petroleum are found in cavities and crevices in the gypsum itself, and the borings were put down on the assumption that when the underlying bituminous shales were struck the source of these oils would be found. These underlying rocks are, however, much disturbed, and no trace of petroleum was encountered when these were reached.

This tilted and faulted character is well seen in the section of these rocks exposed along the lower Avon, and the boring

made near Hantsport in this formation was also devoid of results as regarded the finding of either coal or petroleum. As is Gaspé and elsewhere it may be generally inferred that in such a series of titled and faulted strata the chances of finding oil in economic quantity are by no means good, and the ultimate result of all these attempts, at places so widely separated, will probably be the same.

The only other source of petroleum known to us in this province is the band of "Stellarite", found in association with one of the coal seams of the Pictou basin. This mineral is reported to yield more than 100 gallons of crude oil per ton by distillation, equalling in this respect the Albertite of New Brunswick and the Torbanite of Scotland, both of which are now practically exhausted. No attempt has been made in recent years to utilize this mineral for the manufacture of oil.

It would appear that as a rule the shales of the eastern provinces do not, readily yield oil except by distillation although in places containing a large percentage of bituminous matter in composition; and from the results which have attended the borings at a number of points no large deep-seated reservoirs of liquid petroleum are likely to be encountered from which "gushers" may be derived.

The largest and most important body of these bituminous shales occurs in Albert county, New Brunswick, whence the name "Albert shale". Attention was directed to this locality more than half a century ago by the finding of a body of what was at first supposed to be a coal of superior quality. Some persons, however, contended that the substance had more of the nature of hardened pitch or asphalt and was not a true coal, and a legal contest ensued since the ownership of the property depended upon the actual determination of this question. Finally, after hearing a great mass of so-called expert evidence, the finding of the court was to the effect that the mineral in question was a true coal and not an asphalt, only two

of the experts maintaining its asphaltic nature. Subsequent investigation has clearly shewn that this early decision of the court was erroneous, and it has long since been established that Albertite, as the mineral was called, is merely an altered petroleum.

The Albert shales were for many years regarded as a part of the Lower Carboniferous formation, purely on the evidence of certain fossils, chiefly the remains of fishes. The detailed investigations of 1876, however, shewed them to unconformably underlie the lowest known Lower Carboniferous sediments, and they are now generally held to form the upper part of the Devonian system.

The peculiar feature of these Devonian shales is the presence of bituminous matter throughout their whole extent. While the great bulk of these sediments are shales, beds of sandstone and limestone also occur as a part of the series, and both are also highly bituminous. Interstratified beds of a tough, blackish and massive shale also occur, which break with a roughly conchoidal fracture and contain a much higher percentage of bitumen than the shales of the general mass, which are often thin-bedded.

The source of all this bituminous matter is somewhat obscure; for while according to strict orthodoxy the contained bitumen is supposed to be derived from organic matter contained in the mass of the rock itself, and while in certain layers the remains of fossil fishes are fairly abundant and occasionally the traces of plant life are visible, the proportion of fossiliferous strata, as compared with the great body of bituminous shales, is very insignificant.

The bands of rich oil-shale are sometimes styled Cannelite. They are occasionally grey in colour but for the most part are a blackish-brown. They are clearly a portion of the series, occurring as regular beds. At the old Albert mines, which were near the eastern end of the Caledonia mountain, a very

large deposit of Albertite occurred, and was worked extensively some years ago. This was the mineral first discovered in this district and which was pronounced to be bituminous coal by the courts. It occurred in vein form, following a line of fissure not far from the axis of an anticline in the shales. This deposit extended from east to west for about half a mile, with a width ranging from a few inches at either extremity to a thickness of from fifteen to seventeen feet near the middle of the outcrop. In depth the fissure continued for 1500 feet, the lower 250 feet being for the most part filled with a breccia made up of shale fragments cemented with Albertite.

The extent and value of this deposit can be understood from the fact that during the time of working over 200,000 tons of the mineral were marketed at prices varying from $16.00, in the early years of the industry, to $22.00 per ton, for some years before the mine ceased operations. It yielded about 15,000 feet of gas per ton and more than 100 gallons of oil by distillation.

The Albert shales with their associated oil-bands cover a considerable area in the counties of Albert and Westmorland. They extend from east to west for more than sixty miles, and have a thickness of not far from 1,000 feet. They are thrown into a series of folds, often with steep dips, and are broken by faults at a number of points. To the west they again outcrop near the line of the Intercolonial railway to the vicinity of Hampton, in Kings county. They are in places overlaid by Lower Carboniferous shale and conglomerate, with which are associated large deposits of gypsum and thick beds of limestone in parts also bituminous, and in other places are capped directly by the coarse beds of the Millstone grit.

All the shales of the series yield oil by distillation, the bulk of the formation probably from fifteen to thirty gallons per ton of shale, while the rich oil-bands, or cannelite, yield from 50 to 80 gallons. These bands were about forty years ago

worked for the extraction of the contained petroleum at Baltimore, N. B. They range in thickness from four to eighteen feet, the thicker bands being of the grey variety and found near the upper part of Turtle creek in the western portion of the main field. They can be mined after the manner of ordinary coal-beds, and while the amount of ash is large, reaching in parts from 40 to 50 per cent., the shale burns readily, forming an excellent fuel, both for grates and for the generation of steam. As determined by actual experiment it is claimed that their combustion yields a greater heat and calorific power than can be obtained from ordinary bituminous coals, while the large amount of ash is held to possess certain elements which make it valuable as a fertilizer.

Although these shales contain so large a percentage of bituminous matter they do not readily part with this in the form of free petroleum either by shafting or boring. In support of this statement, it may be said that during the entire period of mining operations at the Albert mines where one would naturally suppose conditions were most favourable for the free escape of the contained oils, according to the statement of the late manager, but slight indications of crude petroleum were observed in any part of the workings, except at one point near the west end of the mine, where there was a slight dripping from the end of the mine, where there was a slight dripping from the sides of the drift. On the Petitcodiac river, near Dover, and at several points in the vicinity, several oil-springs occur, and have usually been regarded as indicating the presence of underlying reservoirs of this material. As at Gaspé and elsewhere, however, in such disturbed rocks these are more probably escapes of petroleum along lines of fracture, and can scarcely be held to indicate the occurrence of oil in quantity in the underlying rocks.

Boring operations have been carried on in this district for more than fifty years. Apparently the first holes were sunk in

the area near Dover and Memramcook, between 1850 and 1860, the exact date being somewhat uncertain, as records of these borings are not now available. It was, however, reported at the time, that small quantities of a thick oil were obtained. Subsequent borings were made at intervals for some years with apparently no better results, but within the present century a systematic search has been carried on in the area between Memramcook and Petitcodiac rivers, in which over sixty holes have been bored, some of which reached depths of more than 3000 feet. While small quantities of oil were struck in some of these holes, as was also the case in Gaspé and in Newfoundland, in rocks of practically the same horizon, in so far as can be learned no outflows have as yet been found in quantities sufficient to warrant the erection of an extensive refining plant, and at present operations have been suspended for some months.

The nearest geological formation to which these Albert shales can be compared from the economic standpoint, are the bituminous shales found in Scotland, and to some extent, in England and Wales. They also occur and have been utilized for the production of oil by distillation in some parts of Australia, in New Zealand, in France, in Germany and in several other countries. In none of these places, however, have they been regarded as producers of crude petroleum in any other way than by destructive distillation.

Their economic importance is evident from the fact that in Scotland and elsewhere millions of pounds have been invested in the erection of large plants for the distillation of the contained bituminous matter, and a brief comparison of some of these Scotch shales with those of New Brunswick may possess some points of interest.

In Scotland, since it is not necessary to discuss the shale-oil industry of other countries, the distillation of oil, first from bituminous coal and then from bituminous shale, was begun by Dr. James Young, of Renfrewshire, about the middle of the

last century. The first experiments were made with the bituminous coals, but the discovery of a mineral, very rich in bitumen, which was known as Bog-head coal or Torbane hill mineral or Torbanite, soon furnished a new supply of the raw material. This Torbanite yielded as much as 130 gallons of crude oil to the ton, as compared with a yield of from 70 to 90 gallons from the coal. After the exhaustion of the Torbane hill mineral attention was directed to the bituminous shales of the coal-measures which were first worked in 1862.

The growth of the shale-oil industry in Scotland may be seen from the fact that the output of this material in 1874 was only 361,970 tons, while in 1891 this has risen to 2,337,932 tons for Scotland alone, yielding 47,63,458 gallons of crude shale oil, the amount of capital invested being for that year no less than £2,664,431, the yield of oil being much greater than the output of crude petroleum in the whole of Canada for the year 1904.

The shale series in Scotland is estimated to have a thickness of about 3000 feet, and in this eight principal bands of oil-shale occur, varying in thickness from two to eighteen feet, and are thus not very different in quantity from those found in the Albert shales of New Brunswick.

Of the Scotch shale bands which most nearly resemble those of Albert county, though none appear to contain as high a percentage of bitumen, the richest, known as the Fell shale, yields from 36 to 40 gallons of crude oil to the ton, and from 25 to 33 pounds of ammonium sulphate; the Broxburn band is probably next in importance with a yield of 28 to 33 gallons crude oil, and from 26 to 32 pounds ammonium sulphate; the Dunnet shales yield from 15 to 30 gallons, and the Curley shales yield about 19 gallons of crude oil and from 50 to 60 pounds ammonium sulphate. In geological position these Scotch shales correspond almost exactly with those of New Brunswick, being situated between the Lower Carboniferous limestone and the Old Red sandstone of the Devonian.

These several oil bands are mined after the fashion of bituminous coals, and are delivered at the distillation works at a cost of four to six shillings per ton. There is also a royalty of from three to tenpence per ton of shale, and the cost of the finished illuminating oil, after crediting the value of the ammonium sulphate, is two and a half pence per gallon. Much of this detail is taken from the valuable work of Boverton Redwood, in whose book on "Petroleum and its products" a very full description of the industry in all its stages is given.

Comparing then the small size of the Scotch seams and the comparatively low percentage of the bituminous contents with the generally thicker beds of Albert county and the much higher percentage of bitumen, the economic importance of these deposits, as a possible source of supply for crude petroleum becomes at once apparent; and in the present strenuous search for new oil-fields and the rising price of the finished product, it would seem perfectly feasible under proper management to operate these New Brunswick areas with a fair margin of profit; more especially in view of the now well established fact that these shales, whenever thev are found, do not readily yield up their bitumen contents except by distillation. The further consideration of this question is, however, a matter for the careful consideration of the best expert engineering skill, and careful management is required in all its stages.

Considered from the standpoint of fuel under steam generating boilers, it has already been hinted that some of these heavy bands of oil-shale possibly could be utilized as a source of heat and power. Of these there are two kinds, the black being especially well developed at the old Albert mines and at Baltimore in Albert county, as well as in parts of the district between the Petitcodiac and Memramcook rivers, having been shipped quite extensively from the latter area for distillation in 1860-65. The grey shales are better developed in the area west of Baltimore on the head waters of Turtle Creek;

the analysis of these shales is of interest and may be here given. They are from the laboratory of Ricketts and Banks, of New York, and are as follows:—

Black oil-shale.

Moisture	0.36	0.64
Volatile	39.50	45.52
Fixed carbon	3.00	5.05
Ash	56.10	48.79
Sulphur	1.04	.....
	100.00	100.00

Grey oil-shale.

Moisture	1.10	1.54
Volatile	45.32	51.22
Fixed carbon	1.29	3.03
Ash	50.69	44.21
Sulphur	1.70	.....
	100.00	100.00

As already stated the origin of the immense amount of bituminous matter contained in this body of shale and sandstone has never been satisfactorily explained, and is a very interesting problem. On no hypothesis yet suggested can it be accounted for either as arising from the decomposition of organic matter *in situ* or as derived from underlying fossiliferous sediments, since the underlying rocks being of pre-Cambrian age are entirely devoid of all trace of organisms. Similar difficulties are also met in the attempt to explain the origin of the great deposits of bitumen found in the island of Trinidad, where the associated rocks are shales of Tertiary age. While the consideration of the several theories put forward from time to time to account for the bituminous deposits throughout the world would be of considerable interest, and while the inorganic origin of bitumen and its compounds has quite a number of supporters at the present day, such discus-

sion is beyond the scope of this paper, and if indulged in would probably leave the final determination of the problem in its present unsatisfactory position.

We may, however, glance for a moment at the enormous output of crude Petroleum which has been obtained from certain parts of the well known oil-fields of the eastern and western hemispheres. Without considering the amounts derived from the smaller areas it will suffice to note that from the official returns of the Geological Survey of the United States, the number of barrels of crude petroleum of 42 gallons capacity, taken from the oil-fields of that country since the commencement of the industry forty-five years ago, amounts to 1,382,815,000, or nearly sixty billions of gallons, by far the greater part of which has been obtained from what is known as the Appalachian district, comprising the states of New York, Pennsylvania, West Virginia, south-east Ohio and Kentucky, only comparatively small portions of which are oil-bearing. These oils are all obtained from the Palæozoic formations. The recent discovery of the immense stores of petroleum in Texas, California and from other areas on the Pacific slope is to some extent already revolutionizing the industries of that portion of the republic by the substitution of oil for fuel on railways and steamships. These oils are from the much more recent horizon of the Cretaceous and Tertiary formations, and some of the areas are already rivalling in productiveness the original seat of the industry in the Appalachian district. The value of the oils for the time mentioned for the entire output to the end of 1904 is given as $1,362,781,879.

The value of the petroleum produced in Canada from the commencement of the industry cannot be correctly stated owing to the fact that for some years the returns were loosely kept. For the period extending from 1881 to 1903, both inclusive, the production of crude petroleum in this country was not far from 530,000,000 gallons, the output being practically all from the

small area in south-western Ontario. The actual value of the output cannot be stated.

In southern Russia a most wonderful revelation as to the amount of crude petroleum which can be obtained from a limited area is presented. Thus from the oil-fields of the Baku district at the southern end of the Caspian sea, in an area of about eight square miles only, and in a period extending only from 1880 to 1904, the output of petroleum amounted to, in round numbers, 950,000,000 barrels of some 40,000,000,000 gallons. The average depth of the wells bored in this district in 1894 was only 1260 feet, the depth having gradually increased year by year. Of the 239 wells sunk in that year the average yield was 384 barrels per day. Such a yield must truly be characterized as enormous, and while some of the wells become exhausted, others are bored from which the same tremendous outflow occurs as when the field was first tapped. If we could take into account the enormous amount of bituminous matter which has passed off in the form of natural gas in all these years in this district, the figures of output would reach such amazing proportions as to be scarcely comprehended, and make the solving of the problem as to the source of such wonderful deposits of bituminous matter, in so limited an area, still more perplexing.

THE FROST AND DROUGHT OF 1905.—BY F. W. W. DOANE, M. Can. Soc. C. E., City Engineer, Halifax, N. S.

(Read 9th April, 1906).

Frost.

The severity of the winter of 1904-5 is still fresh in the memory of the members of the Institute, and the record and effect of the heavy snowfall may be found in detail in the *Transactions* of last year. While the snowfall was extraordinary in itself the extreme severity of the winter was caused by the almost unbroken season of steady penetrating frost.

In ordinary soil in Nova Scotia a depth of two feet limits the penetration of frost; and in designing foundations for structures, footings three feet below the surface are considered safe and will rarely, if ever, be disturbed. In some other formations and under different conditions the penetration is much greater.

In Manitoba frost penetrates at times to a depth of nine feet, and in some towns water pipes are placed at a depth of eleven feet to prevent them from freezing.

In Nova Scotia the lowest temperature reported is about 30° below zero, while in Halifax the lowest record during the last forty years is 21° below in January, 1873, the next being 16° below in January, 1866.

The winter of 1903-4 was much colder than the average, the lowest temperature reached being 9° below in January and 11° below in February. The penetration was almost as great as in 1904-5, but the cold was not so continuous. The settling pond in front of the gate house at Spruce Hill lake froze, so that a man could walk over it—the first time since it was constructed, probably more than forty years ago.

In 1904-5 cold weather set in early and continued with almost unbroken severity for nearly three months. The temperature dropped in January to 7° below zero and in February to 6° below.

The penetration of frost reached a depth in some of the streets of Halifax of six feet. The unprecedented severity of the winter caused water pipes to freeze where frost had never been known before, and the usual waste was largely increased, causing a falling off in pressure on the summits and a water famine in the higher parts of the service.

Many service pipes were frozen, and after spending days and money in cutting down to the pipes and thawing them the greatest care was needed to prevent the frost from closing them again. Hydrants and mains were not immune, and the thawing operations overtaxed the staff of the water department all through the long winter. The frost penetrates more readily and to a greater depth where it can follow the water down a wall, curb-stone or pipe, consequently the pipes are sometimes frozen where the ground around them is unfrozen. The frost works down near the building and follows the pipe out under the street. When a trench or hole has been opened during the winter and refilled with frozen material, it is a difficult problem to prevent the pipes from freezing again. Frost also penetrates more readily in trenches made in rock than in closer filling. Apparatus has been provided for thawing frozen pipes in future by electricity, so that it will not be necessary to open trenches in winter and much delay, expense, annoyance and inconvenience will be avoided.

During the winter (1904-5) Barrington passage was closed by ice for about four weeks. This is a strait through which the tide rushes with a velocity of six to eight miles an hour. It has been closed twice only within the memory of the oldest inhabitant. About forty years ago this passage was frozen over so that men crossed on the ice, and about sixty years ago a load of hay drawn by oxen was taken across on the solid ice.

The writer witnessed a similar incident at Annapolis in 1888. The tide runs very swiftly opposite the town, but ice jammed in the river on the night of January 21st, and during the next thirty days steamers moored some distance down the river were loaded with apples hauled over the ice.

Governor Murray, of Rockhead prison, has kept a record for years of the date on which Bedford Basin froze over and the date on which the ice went out. February 6th was the earliest date for the closing and April 6th the latest day for the opening of this sheet of water. In 1905 it was shut up for the winter on January 24th, and remained frozen down to the Narrows until the ice broke up on April 16th.

There were ice races in the Dartmouth rink on April 3rd, and open-air skating on Milton pond, near Yarmouth, on April 5th.

The severity of the winter and the heavy snowfall chilled the water to such an extent that the lobster fishery along our shores was commenced much later than usual, and it was feared that the prosecution of this industry would be attended with but small results. Fortunately, the worst fears were not realized. The fishermen who followed this pursuit received higher prices in consequence of the conditions, and the results were even more satisfactory than in ordinary years.

Notwithstanding the lateness of the cold season, hedges were opening their leaves on May 8th, and the trees one week later.

The following table shows the lowest temperature for January and February in each year since 1864:—

1864—	January	9 below.	Febuary	.....	4 below.
1865—	"	3 above.	"	.....	2 above.
1866—	"	16 below.	"	.....	12 below.
1867—	"	8 below.	"	.....	5 below.
1868—	"	4 below.	"	.....	7 below.
1869—	"	1 above.	"	.....	6 above.

1870—	January	3 below.	February	4 below.
1871—	"	15 below.		
1873—	"	21 below.	"	5 above.
1874—	"	5 below.	"	zero.
1875—	"	7 below.	"	14 below.
1876—	"	1 below.	"	16 below.
1877—	"	12 below.	"	6 above.
1878—	"	3 below.	"	3 below.
1879—	"	3 below.	"	1 below.
1880—	"	9 below.	"	6 below.
1881—	"	2 below.	"	3 below.
1882—	"	12 below.	"	6 below.
1884—	"	11 below.	"	6 below.
1885—	"	9 below.	"	2 below.
1887—	"	7 below.	"	7 below.
1889—	"	6 below.	"	6 below.
1890—	"	13 below.	"	4 below.
1891—	"	2 below.	"	5 below.
1892—	"	2 above.	"	7 above.
1893—	"	2 above.	"	3 below.
1894—	"	3 below.	"	10 below.
1995—	"	2 below.	"	1 above.
1896—	"	8 below.	"	3 below.
1897—	"	5 below.	"	1 above.
1898—	"	10 below.	"	zero.
1899—	"	5 below.	"	9 below.
1900—	"	1 above.	"	2 below.
1901—	"	13 below.	"	18 above.
1902—	"	zero.	"	4 below.
1903—	"	5 below.	"	4 below.
1904—	"	9 below.	"	11 below.
1905—	"	7 below.	"	6 below.
1906—	"	2 below.	"	1 above.

Rainfall.

The amount of rainfall of any country is dependent upon the situation of the country, its position, the elevation of its hills and mountain ranges, and the prevailing direction of the winds. The influence of trees also has some effect.

The average annual rainfall in Halifax as deduced from long-continued observations covering a period of thirty-seven years, is 55.927 inches. The rainfall of 1905 was 47.795 inches—a deficiency of 8.132 inches, or 85 per cent. of the mean. There was an excess of rainfall in January, February, June, November and December, varying from 11 to 46 per cent. and a deficiency during the remaining seven months. When looked at in the dry light of statistics, the year recently ended seems to have been not unprecedented, still it was an exceptionally dry year. The number of days on which precipitation was recorded, 182, was about the average, but the total precipitation for the year was very near the minimum.

In the year 1894 the total precipitation was 45.808 inches, about two inches less than in 1905. A comparison of the two years shows, however, that at the end of November the rainfall of 1905 was slightly less than that of 1894, the difference of two inches being made in December. In fact, a study of the accompanying tables shows that the year from November 1st, 1904, to October 31st, 1905, is the driest on record, the total precipitation being only 41.685 inches or 74.5 per cent. of the mean. This minimum approaches within about two inches of the rainfall 39.51 inches reported for the year 1860, before the meteorological observatory was established. The accuracy of the latter will be accepted with less reluctance in future.

Long Lake, our great low service reservoir, was raised to overflow level by the melting of the great snows of 1904-5, and water began to run over the waste weir on the 30th of March. The lake continued to overflow until the 19th of May after which the water began to fall. It reached its lowest level on

November 4th—8 feet $4\frac{3}{4}$ inches below the waste weir. On the 16th November Spruce Hill lake was 7 feet 9 inches below the waste weir. The fall rains usually begin in September, but in 1905 the September rainfall was only 74 per cent. of the mean and October 28 per cent. Steps were taken by the city to prevent a water famine, but it was not until November 17th that fears for the efficiency of the supply were relieved. Although the rains came at last the lakes did not recover rapidly as the ground was parched, and to-day Long lake is eight inches below the waste weir, while Spruce Hill lake must rise 46 inches before it will overflow.

The season of 1905 was the driest for over ten years in the eastern States, and reports from England state that it was much below the average there.

The dryness caused much inconvenience in Halifax and was a greater strain on the water system than in 1894, because the consumption of water has increased considerably during the eleven years since the last drought. There is no danger of the low service supply running short, however, as over 1,000,000,000 gallons of water were allowed to run over the waste weir during April and May. The high service lakes were equal to the demand, although they fill up again more slowly in consequence of the comparative difference in water-sheds.

Not every engineer has the time or the opportunity to investigate in detail many points concerned in the observation of rainfall; that work appeals more to the meteorologist. It is sufficient for the engineer that he be able to obtain a trustworthy record. The writer is indebted to the meteorological agent of the Dominion government for the use of his records and valuable assistance in the compilation of the occompanying tables. The means placed at his disposal for making precipitation observations are not what they should be. He should be provided with all necessary self-recording instruments, so that a more complete record could be made and the greatest assistance given to the engineer.

The importance of possessing a reliable and complete record of rainfall appeals more strongly to the municipal engineer than to any other, because drainage and water-systems and water-power construction require for their fundamental basis a reliable record of rainfall upon which the calculations for his design may be based. In the design of drainage works the mean fall is not the conclusive fundamental datum of the engineer, not even the maximum yearly fall, but the heaviest daily fall, and, more particularly, the greatest heavv fall in a short period. The value of having such records from self-recording instruments is two-fold. First, they give an exact indication of the carrying powers of existing sewers; second, they show the demands likely to be made upon sewers and form a valuable basis upon which calculations for the improvement of existing or the design of new sewers can be based. A single gauge is not always reliable for the measurement of the rainfall in any gathering ground as instances are reported of a variation of 50 per cent. in one year where gauges were only one-quarter of a mile apart.

The following form of record would be most valuable to the municipal engineer:—

Date.	Duration of storm.		Total precipitation in inches.	Rate per hour in inches.	20 minutes of maximum precipitation	Period of greatest precipitation.		Rate per hour. In.
	Hours	From				Hours.	From.	

The rain gauge used by the city of Halifax is of brass, cylindrical in form, with a knife-edge rim. The diameter is

$3\frac{1}{2}$ inches. This may seem a very small size for the purpose, but this question was investigated many years ago. After a long series of experiments it was found that the size of gauge or funnel made practically no difference, as gauges varying from 1 to 24 inches in diameter were used with the following results. The 24-inch gauge, being the largest, the rainfall collected therein was taken as 100, and the others were found to read as follows:—

Diameter of gauge..	1	2	4	5	6	8	12	24 in.
Reading	93	96	100	99	102	102	100	100

These results show that except in the case of very small gauges the difference in the amount of rain caught never exceeded two per cent. The adoption of a size from four inches upwards then came to be a matter of convenience, the factors which determine the size being that the instrument shall not on the one hand collect per inch of rainfall an inconveniently small, or, on the other hand, an embarrassingly large volume of water.

The city snow records at the lakes are measured on a board placed in a carefully selected location where it will be free from eddies and drifts. The board is placed level and the snow falling on it is carefully measured with a rule or scale. The depth of melted snow is ascertained by inverting a brass cylinder $3\frac{1}{2}$ inches in diameter on the board. Cylinder and board are then turned upside down so that the cylinder will contain the actual quantity of snow that has fallen within a circle $3\frac{1}{2}$ inches diameter. The snow is melted and measured in a graduated glass in the same manner as rain is measured.

The government observer does not follow the same method for snow measurement, but records the depth of melted snow as one-tenth of the depth of snow falling.

After taking a measurement the snow board is again set perfectly level and at the surface of the snow.

The selection of a site upon which to place a gauge is of primary importance. It should be placed upon a flat stretch of ground, not on the face of a slope, nor on the face of a cliff, nor on a house top. It is a mistake to place it on the top of a dam or embankment, as the accuracy of records obtained from gauges in such positions will be somewhat doubtful. Where the wind is blowing at right angles to the embankment an eddy will be set up parallel to the slope of the bank, which will have a tendency to lift the rain over the top of the bank and produce a comparatively calm area around the gauge.

The volume of rain collected decreases with the height at which the gauge is place above the ground, and experiments have been carried out from time to time to investigate the cause of this decrease. After many heated controversies over the question, it has now been established that this decrease is wholly due to the velocity of the wind and the angle which the rain makes with the horizon. Taking one foot above the ground as representing a catch of 100, at 25 feet above the ground the catch was found to equal about 79 per cent. This gives approximately the ratio of diminution of rain caught with the increase of height. If gauges are not placed at the same level above the ground much of their utility is lost, because it becomes necessary, as in the case of barometic readings, to reduce them to a fundamental level, and the application of such a correction in rainfall work is always open to a doubt. The rim of the gauge should be set perfectly level and one foot above the ground.

While the precipitation records are most valuable in computing the yield of our water-sheds, in order to determine with any degree of accuracy the percentage of rainfall collected and the run-off available for water works or power the evaporation should be determined.

The value of the rainfall for water-works or power-systems is usually determined by the average of the two or three driest years, according to the storage capacity available.

The wettest year was 1896, with a rainfall of 69.862 inches or 25 per cent. greater than the mean for 37 years (55.927 in.)

The driest year was 1894—45.808 inches or 82 per cent. of the mean.

The driest two consecutive years were 1879-80—47.835 and 52.853, an average of 50.344 inches, or 90 per cent. of the mean.

The driest three consecutive years were 1879-80-81, with an average of 50.814 or 91 per cent. of the mean.

The driest twelve months—November 1st, 1904, to November 1st, 1905, 41.685 inches, or 74.5 per cent. of the mean.

The driest twenty-four months, December 1st, 1903, to December 1st, 1905, an average of 50.060, or practically the same as for two calendar years.

The following table gives the maximum, minimum and normal rainfall for each month and for the whole year for thirty-seven years, together with the rainfall during 1905 and the departures from the normal:—

MONTH.	Year.	Maximum (inches)	Minimum (inches)	Average 1869-1905 (inches)	Rainfall 1905 (inches)	Excess or deficiency	Per cent. above or of mean.
January	1895	10.131		5.682	8.290	+2.608	46.
"	1896		1.720				
February ...	1870	9.780		4.769	5.326	+ .557	12.
" ...	1901		0.966				
March	1878	10.284		5.458	2.804	-2.654	51.
"	1889		2.046				
April	1889	7.403		4.000	1.260	-2.740	31.5
"	1886		0.820				
May	1886	8.819		4.025	3.217	- .808	80.
" ...	1903		0.676				
June	1874	7.920		3.800	4.970	+1.170	30.
"	1879		1.191				
July	1896	8.729		3.708	1.927	-1.781	52.
"	1894		1.059				
August	1887	8.351		4.287	2.733	-1.554	64.
"	1899		1.542				
September ..	1896	12.092		3.747	2.753	- .994	74.
" ..	1878		0.800				
October.....	1896	15.039		5.520	1.539	-3.981	28.
"	1897		0.746				
November .	1898	10.248		5.718	6.348	+ .631	11.
" ..	1882		1.392				
December...	1893	10.167		5.213	6.628	+1.055	20.
" ...	1875		1.614				
Totals 1896		69.862		55.927	47.795	-8.132	85.
" 1894			45.808				

PRECIPITATION AT HALIFAX, N. S.

TABLE SHOWING THE MONTHLY AND ANNUAL DEPTH OF RAIN AND MELTED SNOW, EXPRESSED IN INCHES; ALSO THE AMOUNT THAT HAS FALLEN FROM JANUARY 1ST TO THE END OF EACH MONTH, INCLUSIVE DURING EACH YEAR.

YEAR.	January.	February.	January to February. inclusive	March.	January to March, inclusive.	April.	January to April, inclusive.	May.	January to May, inclusive.	June.	January to June, inclusive.
1869	4.530	4.380	8 910	7.950	16.860	2.570	19.430	5.570	25.000	3.920	28.920
1870	6.670	9.780	16 450	3.080	19.530	3.860	23.390	3.190	26.578	1.690	28.270
1871	3.730	5 880	9 610	6.160	15 770	4 880	20.650	2.590	23.240	2.960	26.200
1872	3.880	4.490	8.370	5.370	13 740	2 850	16.590	4.440	21.030	4.230	25.260
1873	7.830	1.610	9 440	4 090	13.530	2.860	16 390	2.340	18.730	2.960	21.690
1874	5.420	5.310	10 730	3.980	14.710	4.550	19.260	4.770	24.030	7 920	31.950
1875	3 481	5 877	9.378	2.113	11.491	3.378	14.869	3.977	18.846	4.067	22.913
1876	3.451	6.456	9.907	6.334	16.241	3.125	19.366	4 664	24 030	3.384	27.414
1877	4 2 0	1.809	6.009	8.666	14.675	3.801	18.476	4.024	22 500	3.841	26.341
1878	7 522	2 697	10.219	10.284	20.503	3.502	24.005	5.759	29 764	4.477	34.241
1879	4.400	3.001	7.401	6.202	13.603	3.481	17.084	4.687	21.771	1.191	22.962
1880	7.733	5.122	12.855	3.365	16 220	4.797	21.717	4.088	25.105	1.343	26.448
1881	3.607	5.329	8.936	6.556	15.492	3.498	18.990	2.460	21.450	5.308	26.751
1882	6.840	5.949	12 789	7.068	19.857	4.824	24.681	4.677	29.358	5.507	34 865
1883	4.930	3.860	8.790	4 941	13.731	3.703	17.434	8.613	26.047	3.322	29.369
1884	4.406	6.161	10.567	7.034	17.601	7.213	24.814	3 629	28.443	3.773	32.216
1885	6.388	5.090	11.478	3.889	15.367	3.520	18.887	3.282	22.169	2.749	24.918
1886	8.670	3.842	12.512	4.027	16.539	0.823	17.362	8.819	26 181	2.708	28.889
1887	7.706	6.735	14.441	4.449	18.890	6.396	25.286	2.126	27.412	2.121	29.533
1888	5.442	6.284	11.726	4.310	16.036	3.675	19.711	2.877	22.588	4.939	27.527
1889	4.391	6.181	10.572	2.046	12.618	7.403	20.021	3.871	23.892	3.755	27.647
1890	3.963	4 645	8.608	9 889	18.497	2.958	21.455	3.970	25.425	3.440	28.865
1891	8.383	8 740	17.123	2.685	19.808	4.010	23 818	4.195	28 013	4.131	32.144
1892	6.321	2.605	8.926	5.986	14.912	2.653	17.565	5.459	23.024	3.638	26.662
1893	4.781	5.979	10.760	2.303	13.063	4.209	17.272	5.054	22 326	1.753	24.079
1894	7.122	3.571	10.693	3 623	14.316	5.648	19 964	1.769	21.733	3.803	25.536
1895	10.131	4.605	14.736	5.931	20.667	3.956	24 623	4.089	28.712	1.827	30 539
1896	1.720	4.199	5.919	8.786	14.705	1.413	16.118	2.532	18.650	4.671	23 321
1897	5.896	2.898	8.794	5.470	14.264	6.211	20.475	4.613	25.088	6.070	31.158
1898	4.060	4.422	8.482	4.068	12.550	7.346	19.896	2.366	22.262	5.598	27.860
1899	5 083	3.613	8 696	7.178	15.874	3.278	19.152	3.677	22 829	3 875	26.704
1900	8.532	5.277	13.809	6.577	20.386	3 949	24.335	4.254	28.589	2.656	31.245
1901	6.043	0.966	7.009	4.102	11.111	6.318	17.429	5.556	22.985	6 959	29.944
1902	3.289	2.735	6.024	7.757	13.781	3.067	16.848	3.725	20.573	4.908	25.481
1903	5.082	3.712	8.794	7.294	16.088	5.515	21.603	0.676	22.279	3.493	25.772
1904	6.318	5.328	11.646	5.590	17.236	5.912	23.148	3.315	26.463	2.668	29 131
1905	8.290	5.326	13.616	2.804	16.420	1.260	17.680	3.217	20.897	4.970	25.867
1894	7.122	3.571	10,693	3.623	14.316	5.648	19.964	1.769	21.733	3.803	25.536
Average	5.682	4.769	10.451	5.458	15.909	4.000	19.909	4.025	23.934	3.800	27.734

PRECIPITATION AT HALIFAX, N. S.

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YEAR.	July.	January to July, inclusive.	August.	January to August, inclusive.	September.	January to September, inclusive.	October.	January to October, inclusive.	November.	January to November, inclusive.	December.	Total for the Year.
1869 ..	2.920	31.840	2.580	34.420	1 570	35.990	7.300	43.290	5.470	48.760	5.770	54.530
1870 .	3.210	31.480	2.200	33.680	3.330	37.010	6.830	43.840	6.440	50.280	5.880	56.160
1871 ..	3.380	29.580	3 690	33.270	4.810	38.080	4.490	42.570	4.180	46.750	4.390	51.140
1872 ..	2.880	28.140	6.820	34.960	1.410	36.370	4.880	41.250	6.650	47.900	6.160	54.060
1873 ..	3.900	25.590	4.450	30.040	4.480	34.520	8.630	43 150	7.980	51.130	4.310	55.440
1874	2.290	34.240	3.370	37.610	5.040	42.650	2.460	45 110	3.580	48.690	5.490	54.180
1875 ..	5.612	28.525	3.555	32.080	2.060	34.140	9.976	44.116	5.544	49.660	1.614	51.274
1876 ..	3.914	31 328	1.909	33.237	6.094	39.331	4.068	43.397	7.397	50.796	3.176	53.972
1877 ..	4.468	30.809	3.539	34.348	3.164	37.512	6.857	44.369	8.678	53.047	4.493	57.540
1878 ..	1.483	35.724	3.127	38.851	0.800	39.651	5 061	44.712	6.909	51.621	5.119	56.740
1879 ..	3.843	26.805	4 827	31.632	2.596	34.228	4.755	38.983	4.823	43.806	4.029	47.835
1880 ..	3.086	29.534	3.920	33.454	5.712	39.166	4.590	43.756	4.704	48.460	4.393	52.853
1881 ..	3.177	29.935	3.062	32.990	3.105	36.095	4.206	40 301	4.420	44.721	7.034	51.755
1882 ..	5.071	39.936	3.925	43.861	5.914	49.775	7.403	57.178	1.392	58.570	3 452	62.022
1883 ..	3.540	32.909	5.34	38.251	3.864	42.115	5.841	47.956	3.478	51.434	6.678	58.112
1884 ..	8.294	40.510	2.771	43 281	1.788	45.069	3.093	48.162	5.992	54.154	9.124	63.278
1885 ..	5.817	30.735	3.001	33.736	2.497	36.233	6.280	42.513	5.423	47.936	8.693	56.629
1886 ..	6.525	35.414	4.526	39.940	4.459	44.399	2.135	46.534	5.284	51.818	5.469	57.287
1887 ..	2.045	31.578	8 351	39.929	3.308	43.237	3.058	46.295	6.718	53.013	4.120	57.133
1888 ..	5.001	32.528	7.000	39.528	5 331	44.859	6.859	51.718	6.802	58.520	7.774	66.294
1889 ..	2.668	30.315	2.633	32.948	1.399	34.347	4.179	38.526	7.145	45.671	2.988	48.659
1890 ..	2.141	31.006	7.042	38.048	4.534	42.582	6.603	49.185	3.716	52.901	7.202	60.103
1891 ..	4.003	36.147	3.385	39.532	3.052	42.584	9.621	52.205	2.388	54 593	4.076	58.669
1892 ..	2.710	29.372	6.809	36.181	1.744	37.925	3.472	41.397	9.240	50.637	3.053	53.690
1893 ..	4.757	28.836	5.954	34 790	4.391	39.181	5.640	44.821	3.760	48.581	10.167	58.748
1894 ..	1.059	26.595	3.993	30.588	1 010	31.598	3.863	35.461	5.785	41.246	4.562	45 808
1895 ..	3.924	34.463	5.5[illegible]2	39.965	2.491	42.456	5.627	48.083	8.223	56.306	5.846	62.152
1896 ..	8.729	32.050	3.037	35.087	12.092	47.179	15.039	62.218	4.396	66.614	3 248	69.862
1897 ..	3.661	34.819	5.185	40.004	1.169	41.173	0.746	41.919	6.051	47.970	3.552	51.522
1898 ..	3.652	31 512	5.651	37.163	4.158	41.321	4.845	46 166	10.248	56.414	4.066	60.480
1899 ..	5.747	32.451	1.542	33.993	3.201	37.194	6.191	43.385	4.590	47.975	5.038	53 013
1900 ..	1.872	33.117	3.993	37.110	5.043	42.153	7.365	49.518	6 858	56.376	3.321	59.697
1901 ..	1.585	31.529	3 656	35.185	6.872	42.057	4.906	46.963	2 560	49.523	8 573	58 096
1902 ..	1.651	27.132	4.767	31.899	4.657	36.556	4.252	40.808	3.813	44.621	7.295	51.916
1903 ..	4.313	30.085	4.247	34.332	4.237	38.569	6.368	44.937	9.598	54.535	4.590	59.125
1904 ..	2.323	31.454	6.511	37.965	4.502	42.467	5.031	47.498	5 007	52.605	1.859	57.194
1905 ..	1.927	27.794	2.733	30.527	2.753	33.280	1.539	34.819	6.348	41.167	6.268	47.435
1894 ..	1.059	26.595	3.993	30.588	1.010	31.598	3.863	35.461	5.785	41.246	4.562	45.808
Aver..	3 708	31.442	4.287	35.729	3.747	39.476	5 520	44.996	5.718	50.714	5 213	55.927

PRECIPITATION AT HALIFAX, N. S., 1905.

Table Compiled from Returns of Dominion Government Meteorological Agent, Showing Depth of Rainfall and Melted Snow in Inches and Duration of each Storm in Hours. (T = trace.)

Day of Month.	January.		February.		March.		April.		May.		June.	
	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.
1	1.0	.050	....	....	6.2	.470	....	......	3.3	.298	....	......
2	3.0	.020	....	......	....	....	1.3	T	1.0	.154	6.0	.925
3	9.0	.334	1.0	.010	....	......	6.0	.020	2.7	.082	1.0	.054
4	13.5	2.128	....	......	.3	T	....	......	11.6	.704	....	......
5	.3	T	....	......	.5	T	2.0	.027	....	......	....	......
6	....	......	3.0	.030	11.0	.240	19.5	.258	1.0	.020	8.0	1.681
7	1.8	.184	8.2	.390	....	.....	9.0	.136	10.0	.332	....	....
8	5.0	.592	2.5	.040	15.5	.634	....	.....	....	.....	6.8	.328
9	.1	T	....	......	4.7	.300	....	......	4.6	.467	....	......
10	4.3	.325	6.0	.220	12.8	.402	3.0	.034	2.5	.058	1.0	.038
11	....	......	.8	.020	....	......	2.5	.032	....	......	....	......
12	10.5	.880	....	......	....	....	6.0	.128	....	......	.8	.032
13	3.0	.190	10.0	.958	....	....	....	....	....	....	15.2	.452
14	....	......	1.0	.048	....	......	1.0	.062	.4	T	....	T
15	....	....	1.0	.020	....	....	....	....	.3	T	...	......
16	....	.....	17.7	1.870	....	......	....	......	.4	T	....	T
17	2.0	0.60	1.8	.020	....	.....	....	T	7.0	.082	.5	.010
18	....	......	2.5	.090	....	....	...	......	9.3	.270	10.5	.696
19	2.2	.067	....	.....	2.0	.080	....	....	....	..	....	....
20	....	.....	1.8	.040	2.5	.030	....	....	4.0	.090	....	......
21	....	......	1.8	.110	....	..	2.9	.056	.5	T	3.7	.054
22	.50	T	....	.....	....	...	5.3	.253	....	....	7.5	.048
23	6.8	.820	7.5	.440	....	.....	.5	T	....	.....	5.5	.010
24	....	......	10.0	.140	....	......	....	....	....	....	....	......
25	5.0	.420	13.0	.270	....	......	.5	.010	....	......	2.0	.010
26	18.0	1.180	....	......	2.0	.120	....	.....	....	....	8.5	.268
27	3.5	.140	5.5	.580	2.5	.090	....	......	2.2	.036	12.0	.270
28	1.8	.020	1.6	.030	10.3	.426	....	.....	3.6	.392	7.8	.082
29	5.0	.100	...	......	.5	.012	9.5	.144	.5	.010	1.0	.012
30	....	.....	....	......	....	.....	4.8	.100	4.5	.222	....	....
31	18.0	.780	...	.....	....	......	....	......	....	......	....	.....
	....	8.290	....	5.326	....	2.804	....	1.260	....	3.217	....	4.970

PRECIPITATION AT HALIFAX, N. S., 1905

TABLE COMPILED FROM RETURNS OF DOMINION GOVERNMENT METEOROLIGICAL AGENT, SHOWING DEPTH OF RAINFALL AND MELTED SNOW IN INCHES AND DURATION OF EACH STORM IN HOURS. (T=trace.)

Day of Month.	July.		August.		September		October.		November		December.	
	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.	Hours.	Inches.
1	....	......	2.8	.028	....	......	....	......	7.0	.460	....	......
2	....	......	13.5	.315	....	......	....	......	1.5	.185	....	.328
3	13.8	.436	....	......	....	......	....	......	....	......	....	1.086
4	.5	.011	....	......	12.6	1.116	....	......	2.5	.048	....	T
5	....	......	....	......	6.0	.558	....	......	4.5	.608	....	......
6	....	T	4.5	.372	4.7	.134	.3	T	....	......	....	......
7	....	......	2.5	.986	5.3	.182	....	......	8.2	.732	....	T
8	....	......	....	......	....	......	....	......	.5	T	....	......
9	....	......	....	......	....	......	....	......	1.4	.098	....	2 380
10	....	......	1.5	.061	....	......	....	......	....	......	....	.034
11	....	......	....	......	....	......	....	......	....	......	....	......
12	....	......	8	.028	....	......	....	......	.3	T	....	.396
13	.5	T	.7	.020	4.5	.228	3.1	.188	....	......	....	.010
14	....	......	.	......	2.0	.126	....	......	2.0	.040	....	......
15	2.5	160	....	......	....	......	....	......	....	......	....	......
16	....	......	13.8	.426	2.0	.035	....	......	6.5	.172	....	......
17	4.8	.088	....	......	....	......	....	......	19.3	1.803	....	......
18	3.2	.052	....	......	5.2	.072	....	......	....	......	....	.428
19	....	......	....	......	2.0	.028	8.6	.184	....	......	....	......
20	....	......	7.3	.165	11.5	.236	13.0	.728	....	......	....	......
21	....	......	....	......	1.0	.038	2.8	.071	....	......	....	.100
22	....	......	....	......	....	......	....	......	....	......	....	.822
23	....	......	1.0	.312	....	......	....	......	....	......	....	.046
24	.1	T	....	......	....	......	....	......	....	......	....	108
25	.2	T	....	......	.2	T	4.0	.368	6.8	.010	....	......
26	....	......	....	......	.1	T	....	......	....	......	....	......
27	.5	.034	....	......	....	......	....	......	3 5	.112	....	......
28	.1	T	.3	T	..	......	....	......	1.5	.020	....	T
29	....	......	....	......	....	......	....	......	17.0	1.488	....	.392
30	....	......	.3	.020	....	......	....	......	5.5	.572	....	.498
31	13.5	1.146	....	......	....	......	....	......	....	......	....	T
	....	1.927	....	2.733	....	2.753	....	1.539	....	6.348	....	6 628

PRECIPITATION AT HALIFAX, N. S.

TABLE SHOWING THE NUMBER OF TIMES THAT THE TOTAL PRECIPITATION, EACH DAY FROM 1894 TO 1905, INCLUSIVE, HAS BEEN NEAREST TO A SERIES OF AMOUNTS RANGING FROM ONE-HUNDREDTH OF AN INCH TO FOUR AND A HALF INCHES.

YEAR.	QUANTITY IN INCHES.																									Total Rainfall for the Year.	YEAR.
	$\frac{1}{100}$	$\frac{1}{10}$	$\frac{2}{10}$	$\frac{3}{10}$	$\frac{4}{10}$	$\frac{5}{10}$	$\frac{6}{10}$	$\frac{7}{10}$	$\frac{8}{10}$	$\frac{9}{10}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$		
1894........	50	42	13	16	9	7	5	5	5	6	2	2	2	....	....	....	....	....	1	...	..	....	...	...	...	45.808	1894
1895........	33	31	23	14	10	6	4	10	7	1	8	5	3	2	....	2	....	....	....	....	....	...	....	....	....	62.152	1895
1896........	45	30	19	12	10	8	5	7	6	3	2	3	6	1	....	....	1	....	....	1	1	....	1	...	1	69 862	1896
1897........	48	54	15	16	7	11	6	4	2	5	3	4	1	1	...	....	..	....	1	....	....	....	....	....	....	51 522	1897
1898........	46	34	20	17	14	9	6	6	6	4	3	8	2	....	....	1	....	1	....	....	....	....	....	..	....	60.480	1898
1899........	49	23	16	7	5	7	7	5	8	5	3	5	3	1	....	1	....	1	....	....	....	....	....	....	....	53.013	1899
1900........	38	47	18	13	12	6	12	4	2	6	5	5	2	2	1	1	...	....	..	....	....	..	....	....	....	59.697	1900
1901........	56	41	11	18	8	4	2	3	4	1	5	5	4	2	2	1	....	....	1	....	....	....	1	....	....	58.096	1901
1902........	46	44	17	20	15	5	3	7	5	3	4	2	2	1	....	1	....	....	1	....	....	....	....	....	....	51.916	1902
1903........	38	24	23	24	9	10	5	6	3	2	4	3	2	3	3	....	....	1	....	....	....	....	...	....	...	59.125	1903
1904........	37	36	20	18	10	8	6	6	4	3	4	5	2	1	3	....	1	....	...	..	....	....	....	....	....	57.194	1904
1905........	44	35	15	15	13	5	6	4	3	2	4	2	1	2	2	....	1	....	...	..	....	....	....	....	..	47.795	1905
Totals ..	530	441	210	190	122	86	67	67	55	41	47	49	30	16	11	7	3	3	4	1	1	....	2	....	1	676 660	Totals.
Means...	44	37	17	16	10	7	5.6	5.6	4.6	3.4	4	4	2.5	1.3	1	.6	25	.25	3	.1	.1	....	.17	....	.1	56.388	Means.

QUANTITY OF WATER DISCHARGED OVER LONG LAKE WASTE-WEIR IN GALLONS.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August	Septemb'r	October.	Novemb'r	December	Total.	Precipitation in inches.	No. of days Rain or Snow fall.
1892	211,226,360	....	241,903,243	57,186,763	84,085,451	17,123,963	12,381,389	55,196,703	5,831,022	....	229,960,879	95,307,034	1,010,202,807	53.690	......
1893	982,576	60,758,585	....	332,062,217	173,923,963	....	....	....	....	....	....	521,481,528	1,089,208,879	58.740	......
1894	17,198,557	118,639,579	189,455,675	582,602,480	12,516,049	....	....	....	....	....	....	....	920,412,340	45.808	166
1895	187,238,515	15,399,804	104,959,943	398,219,715	7,042,134	2,779,021	....	....	....	....	....	199,308,252	914,947,384	62.152	161
1866	10,639,329	....	495,949 894	78,609,225	....	....	....	....	412 374,620	1,045,458,665	80,678 961	49,409,208	2,173,119,902	69.862	183
1897	101,190,514	....	88,923,753	447,206,304	120,165,769	96,958,138	13 240,719	....	....	....	....	....	867,685,197	51.522	193
1898	....	....	38,354,174	681,939,737	62,736,359	224,848,481	....	5,088,822	....	48,802,036	758 002,940	233,351,627	2,053,124,176	60.480	196
1899	264,355,317	....	305,513,150	682,500,339	98 583,572	26,698,635	....	....	....	....	44,555,834	103,361,274	1,524,568,121	53.013	169
1900	73,594,939	643,645,456	744,897,071	416,994 078	403,136,002	....	....	....	....	....	....	....	2,282,267,546	59.697	198
1901	163,528,558	14,417.228	142,220,672	723.579,284	99,238,010	227,294,520	725,898	....	....	....	....	108,307,998	1,479,312,168	58.096	195
1902	238,435,990	....	664,586,695	184 352,747	....	....	....	....	....	....	....	10,665,474	1,098,040,906	51.916	188
1903	171,178,014	....	456,210,407	524,039.759	....	....	....	....	....	....	161,989,078	337,810,982	1,651,228,240	59.125	179
1904	54,293,952	23,023,428	402,429,789	568,754,199	112,990,817	7,877,994	....	....	....	....	....	....	1,169,370 179	57.194	196
1905	....	....	43,832,254	914,509,990	113,896 013	....	....	....	....	....	....	....	1,072,238,257	47.795	182
Avg	106,704,473	62,563,149	279,945,480	470,894,774	92,022.438	43,041,482	1.882,000	4,306,109	29,871,832	78,161,479	91,084,835	118,500,242	1 378,980,436	56.364	184

EELS IN WATER PIPES AND THEIR MIGRATION.—BY WATSON L. BISHOP, Superintendent of the Dartmouth Water Works, Halifax Co., Nova Scotia.

(Read 9th. April, 1906.)

The early history of the eel (*Anguilla vulgaris*) is involved in mystery. No other common fish has so completely baffled scientific investigators. The Greek poets jocosely remarked "that since all children whose paternity was doubtful were ascribed to Jupiter, he must be considered the progenitor of the eel." Aristotle emphatically stated that eels are spontaneously produced from the mud and moist earth. About sixty years ago, Martens, a famous naturalist stated, "Among all the animals that surround us, the eel is the only one which has never unveiled the secret of its propagation, even to the most perservering investigators." From that time to the present the most persistent efforts have been made to solve the mystery of the sexual characteristics of this fish and its reproduction.

In 1896, G. B. Grassi, a professor in Rome, after four years devoted exclusively to the study of this fish, and years of previous inquiry, communicated a paper to the Royal Society of London, which practically solved this mystery. He established the fact that the eel reproduced itself only in very deep water, at least 1500 feet in depth; that the eggs deposited, float there in these great depths; that the young when hatched take a form not recognized previously as the young of the eel, but described under the name *Leptocephalus brevirostris,* which proves to be its larval form; that this fish passes through a metamorphosis in a few weeks, and then becomes the eel known to all when about two inches in length; that in a very short time it seeks the fresh water to acquire sexual maturity and go on with the work of reproduction; that the parent eel then dies, and

therefore the mature eel never returns again to the fresh water. He also shows with others, that the female eel grows to a much greater size than the male eel, while the latter rarely exceeds a foot or fourteen inches in length, although the female frequently attains a length of six feet, and a weight of from twelve to fifteen pounds.

The fact that the eel has to seek such great depths in the open ocean in order to become sexually developed, and has to remove itself far from the usual haunts of man, and the further facts that special ships and apparatus had to be fitted out for its capture, and that but very few localities on the globe are available for the study of the mature fish and its young, were the causes which prevented scientists from learning sooner the secrets of its life history.

As there is still a great deal left to be learned, from the fact that this fish is noctural and secretive in its habit, I thought it might be of some interest to place before you the result of some investigations I have made during the past few years regarding its habits.

Since the water system was installed in Dartmouth in 1892, until 1904, eels caused considerable trouble by getting into the main pipe at the intake, and thence finding their way through the mains to the service pipes in the town, and plugging them up. The lakes from which we draw our supply are about eight miles from the sea by following the stream. This stream passes through other small lakes before reaching the salt water.

The time of year when eels gave us most trouble was during the months of September and October. At this season men were constantly employed in digging up the service pipes to take out these obstructions. It almost invariably happened that the services which were troubled most by them were the ones having leaky fixtures. The eel imprisoned in the pipes would be constantly feeling for any current whereby it might escape, and would thus get into the services. Digging up so many pipes being so expensive, and also damaging to a well finished

street surface, as well as being annoying to householders, I eventually discovered a plan which proved more satisfactory and economical. I found that by attaching a strong pump to the service pipe into the house, by means of which the eel could be easily forced back into the main, (which we frequently did against a pressure of 90 pounds), the eel being dead, or nearly so, was easily carried along with the current and taken out of a hydrant opened for this purpose. It was sometimes necessary to shut a valve to divert the flow of water in the direction of the hydrant.

During the above-mentioned migatory season, there had been no water going over the waste weir. The only water going from the lakes was by way of the water pipes. From the above facts, and from noting that after heavy rains occurred, many eels would be taken from the water pipes, I came to the conclusion that at such times they must gather about the intake in great numbers, trying to follow the current of the water to reach the sea.

The water enters the screen-chamber through an opening two feet wide by nine feet deep. In this opening three screens were placed one above the other. In the bottom screen, which is two by three feet, I cut in the centre a hole sixteen inches in diameter and fitted to it a funnel-shaped intake of screen cloth, 8 by 8 mesh, No. 16 wire, leaving a circular opening of one and a half inches to admit eels. I then boxed off the back of the screen with the same material. It can be readily seen that eels trying to follow the flow of water would easily find their way into this trap, from which there is no escape except through the small funnel opening by which they came in. The peculiar construction of this trap makes this opening very difficult to find from the inside; therefore, eels one in, remain there until they are taken out.

The trap was put in position on the 29th of April, 1904, and on May 6th eighty-nine eels were found in it. Three were about one foot long, the remaining eight-six were small, from

four to eight inches in length, the average length being 5.96 inches.

May 13th, forty-four were taken. The four largest were about one foot, while the remainder were small, similar to the ones taken the week before.

May 30th, sixty-one were caught. Two of these were large, being about eighteen inches long, the others were small like the ones previously taken.

June 17th, twelve were caught; seven of which were small, and five quite large.

June 29th, the trap was empty.

July 19th, thirty-six were in the trap. Two were small, the others quite large.

August 5th, twenty-three were caught, measuring from twelve to eighteen inches in length.

August 19th, fifty-one were caught; all were the size of those taken from the service pipes, about one foot long.

August 26th, three hundred and eight eels were found in the trap, ranging in length from twelve to fourteen inches, except two which were much larger. By referring to the precipitation of that year it will be seen that on the 21st the rainfall was 2.44 inches, and on the 23rd 0.43 of an inch.

September	2nd,	11	were	taken.
"	8th,	23	"	"
"	16th,	41	"	"
"	23rd,	2	"	"
October	5th,	22	"	"
"	14th,	46	"	"
"	21st,	0	"	"
"	28th,	2	"	"

The trap was then taken out, the migratory season being over, with a total catch of seven hundred and eighty.

After the large catch on August 26th, as shown by the above data, few had found their way into the trap for several days.

It is likely, therefore, that nearly all the eels in the vicinity of the trap were caught, and that they were scarce about the gate-house until the few which were not in the first run had found their way to the intake. It has also been shown that nearly all the eels taken in the early spring were small, probably one year old, and during their earlier life had remained in the lakes nearer the sea.

The lakes in question being so far from the sea, and the outlet from them passing through other lakes in its course, it does not appear necessary that they should make the entire journey the first year.

What confirms me in this belief is, that several years ago I saw during the spring, at the head of the tide waters of the Cornwallis river, in King's County, N. S., many thousands of small eels working their way up the stream in the shallow water at each side of the river. These were certainly not more than two and a half to three inches long. To form an idea of the great numbers passing along I judged that there was one hundred or perhaps more in a space of two feet.

This stream of eels was continuous without a break as far as they could be seen each way. It can readily be seen that vast quantities were finding their way to the spacious still waters in the meadows about half a mile further up the stream. Unfortunately, I cannot give the exact date on which this observation was made.

I am of the opinion that the first catches in the spring, which were nearly all of small size, had just reached the lake by way of the stream, and being naturally somewhat tired, had settled in the deep water to rest, and had thus found their way into the trap at the intake which was only about one hundred feet from where they entered the lake. A subsequent experiment, which is explained later, proved the foregoing assumption to be correct.

On April 19th, 1905, the eel trap was again put in place in the gate-house, and when visited on May 9th it contained one

hundred and twenty-three small eels, the same size as the ones taken in the early spring of the previous year. On this date, May 9th, I also put a trap in the overflow with the opening facing down stream to intercept eels that might be coming up into the lake.

May 17th this trap was examined and found to contain eighty-nine small eels, thirteen small trout, one small sucker, and one minnow. On the same date only eighteen small eels were taken from the trap in the gate-house.

June 1st sixty-six small eels, ten small trout, and four suckers were taken from the trap in the overflow, and only 9 small eels were in the trap in the gate-house. This proves in two ways that my theory was correct, and that the small eels taken in the early spring of 1904 had just reached the lake. A confirmation is found in the fact that while the two traps were in use, the trap in the stream stopped nearly all that were going into the lake, so that there were only a few to get into the trap in the gate-house.

The trap in the overflow stream was taken out June 1st, 1905.

June 9th, six eels were in the trap in the gate-house;

June	24th,	2	were	taken.	Oct.	6th,	5	were	taken.
July	1st,	2	"	"	"	12th,	0	"	"
"	14th,	1	was	"	"	21st,	23	"	"
"	24th,	14	were	"	"	28th,	4	"	"
"	29th,	0	"	"	Nov.	4th,	6	"	"
Aug.	5th,	5	"	"	"	10th,	0	"	"
"	15th,	22	"	"	"	18th,	7	"	"
"	24th,	9	"	"	"	25th,	0	"	"
Sept.	1st,	9	"	"	"	30th,	3	"	"
"	7th,	50	"	"	Dec.	7th,	1	was	"
"	19th,	19	"	"	"	18th,	0	were	"
"	26th,	12	"	"					

On December 27th no eels were found and I took the trap out, the lake being then frozen over. The trap was kept in

several week later than the previous year. The autumn (the migratory season for eels) being unusually dry, they did not seem to be moving as in the previous year. The trap was therefore kept in to find whether they would migrate when sufficient rain had fallen to raise the lakes and streams. The rain held off, however, until about the middle of November, and it was then so late there was no noticeable movement of the eels.

Many water-works men have held that the way eels get into the water pipes is by getting through the screens when very small, and that they live in the pipes until they are about a foot long and then they find their way into the services. I cannot credit this, as they would then be giving trouble all the year round, and would not get in the pipes periodically as they now do. It has also been pointed out that if an overhanging dam were put across the stream the small eels could not reach the lake, and in a few years there would be no small eels in the lakes to get in the water pipes. This idea seems quite reasonable, but I do not think it complete enough to be entirely successful. I think the ends of the dam should be arranged so as to prevent eels passing around the end of the dam on the land, and thus reaching the stream above.

That eels are well able to pass around or over a dam, there can be no doubt. I tried an experiment with one lot taken from the trap with the following results: They were put in a box without water, and kept in a room where the temperature was fifty-six degrees (Farenheit), and at the end of twenty-seven hours two were put in water and soon became lively, and appeared as well as though they had never been taken from the lake. The others appeared to be in about the same condition. The largest one lived forty-three hours. Other experiments tried later in the summer proved that eels fifteen to eighteen inches long, will live longer than small ones. In one case I had one to live out of water for seventy-two hours.

Judging from these facts, these fish can leave the water in the night while the grass is wet with dew or rain, and remain

out of water for several hours without any inconvenience. As they can move through wet grass very readily, it is therefore evident that they can travel overland for considerable distances should occasion require it.

What would likely be the most effectual way to prevent them from getting into the lakes, would be to put lime in the stream every evening, commencing in the spring as soon as the stream is free from ice, and continuing until the migratory season is over. It is a well known fact that eels have a great dislike for lime, and it is not at all likely they would enter a stream where the water was charged with it. Lime is often used in earth dams to prevent eels from boring through and thus causing leaks or washouts.

I expect to continue catching eels both at the intake and in the overflow stream, to determine whether their numbers will be lessened in the lake, and if by taking the small ones on their way to the lake, it will decrease their numbers returning to the sea in the autumn.

Since the trap has been in use, there have only been two or three eels taken from the service pipes each year; whereas, in former years, from thirty to fifty were taken out of the water pipes each autumn during the downward migratory season. This proves conclusively that the work for which it was intended, that is, to catch the eels at the intake and thus prevent them from entering the water-mains, has been successfully accomplished by the trap.

In conclusion, I find that this troublesome fish goes up streams in the spring months in large numbers, and that during the autumn the mature fish returns to the sea. During the summer months a few are caught in the trap, but I attribute this to accident instead of migration. The eels are simply feeding around or looking for a dark spot in which to hide during the day, and thus get entrapped.

That they can be effectually stopped from getting into the service pipes is certain if sufficient care is taken.

Whether or not the quality of the water will be affected adversely by keeping all the eels out of the lake is to me an open question. The eel is well known to be a great scavenger ; but on this subject I have not secured sufficient data to form an opinion.

Discussion.

F. W. W. Doane.—The eel nuisance has been a most perplexing problem for every superintendent of a water system. It is at times very difficult to account for their presence in pipes. There is no doubt in the mind of the writer that eels will climb over a screen projecting from eighteen inches to two feet above the water. Traces of eels have been noted on the top of the screens in the gate-houses, and on one occasion an eel was caught in an effort to surmount the obstructing screens. The carelessness of a gate-keeper sometimes permits their entrance through a small hole worn or torn in the screen or where the corner of the screen frame unprotected by metal has become worn. In the Halifax screen chambers there are two sets of grooves for screens separated only by a thin angle-iron. It was suspected that eels got in while the screens were being changed, consequently a batten was placed on the back of the lower front screen at the bottom edge so that the space between the two sets of screens was completely filled. By always putting in the new screens before removing the old set, there is no opportunity for eels to get between them.

Anguilla vulgaris is supposed to be long lived, one authentic instance being recorded of an eel which was at least thirty-one years old.

There is no doubt of the ability of eels to travel over land. On more than one occasion Halifax water department officials have seen them, when thrown out of a trench or stream (near the lakes), start for the lake.

When migrating, no ordinary obstacle seems to stop them. It is claimed that they have been known to cross from one water to another by ascending a branch of a tree hanging in the water

and dropping on the other side. They have been known to climb steep ascents also.

It is probable that the migration down stream is made at night, dark nights being chosen, and moonlight being sufficient to stop them. The young eels going up in the spring travel by day.

It is claimed that eels are peculiarly averse to cold, and that the temperature of the brackish water of estuaries is always higher than that of unmixed salt or fresh water. Eels bury themselves in winter a foot or more in the mud near the outlet of a stream, and are taken with a spear. It is uncertain whether such eels spend the summer in salt or fresh water. To the ordinary observer there is little difference in appearance between the eels taken during the summer in salt water and those taken from the lakes.

On one occasion eels filled a main on Granville Street, Halifax, so completely that when the pipe was cut it became necessary to make an auger to bore the pipe out.

The result of Mr. Bishop's study and experiments is most interesting, and further work will add equally valuable information. A better acquaintance with the habits of eels will be the means of saving much money and annoyance, and may enable superintendents to prevent entirely the entrance of eels to the pipes of water systems.

R. H. Brown.—At Sydney Mines, Cape Breton, some years ago, we made a reservoir by closing the culvert in an embankment on the colliery railway. The dry valley thus closed was converted into a lake of a few acres in extent and some ten feet deep at the middle. Its source of water supply was the drainage of the fields on the surrounding slopes, and its only outlet was by pipes of four inches diameter and about two thousand seven hundred yards in length, which conducted the water from this reservoir to the colliery engines at the Princess pits. After a few years eels were found in the pipes obstructing the flow of

water. The eels taken out were of usually good ordinary size; but on one occasion when we found the water completely stopped at a certain point, we had to break a pipe there, and found in it a living eel of about four inches in diameter (the full size of the pipe) and between three feet six inches and four feet long. The eels had no possible waterway by which to get into our reservoir, but must have travelled overland for about half a mile from a brook that runs into the Big pond. The Big pond, in which eels were plentiful, was a salt-water lake, having connection with the sea by a channel through a sand bar. These eels on their way had to pass over the railway embankment, above mentioned.

The eels in Cape Breton do not seem to migrate; they are seen in abundance, both in summer and in winter, in all the lagoons and estuaries around the coast and in the Bras d'Or lake. In summer they move about among the long eel-grass looking for food, and in winter they lie dormant in the mud in the same localities.

I once in July was watching a large shoal of smelts entering the barrasois at Indian brook, near St. Ann's, C. B., and noticed a number of large eels passing along among them. At frequent intervals an eel would be seen to turn quickly and bite a smelt; the latter at once turned on its side and floated helplessly down the channel followed by the eel, who, I presume, devoured it at his leisure.

Water Powers on the Mersey River, N. S.—By W. G. Yorston, C. E., City Engineer, Sydney, N. S.

(Read 21st. May 1906.)

The province of Nova Scotia is the second smallest of the provinces composing the Dominion of Canada. It comprises about 21,000 square miles of territory in a shape of a rather narrow peninsula about 350 miles in extreme length, and with an average width of less than 100 miles. Owing to its shape the province cannot boast of any very large rivers, but in some of those rivers that we do possess nature has placed in our hands rather valuable forces, which have up to the present time been only partially made use of, partly from the lack of purpose to apply the power to. The resources of the province are rich and varied, and it is especially rich in its mines and minerals. In the last few years a rapid development has taken place in Nova Scotia, and in the course of such development the question of power has naturally forced itself to the front, cheap power being essential to the successful operation of large factories, or even to the mining of any kind of mineral. My own belief is that the development of the resources of the provinces is only beginning, and in a few years time great strides will be taken in the opening up of resources that have already lain for too great a time undeveloped. Believing that such is the case, the question of cheap power becomes at once a large and important consideration, and it is safe to predict that before very long every availbale water-power of any size in the province will be producing energy for the operation of factories and other purposes for which power is required.

Our neighbours in the south have for many years recognized the value of their water-powers in connection with the development of the country, and have created a special depart-

ment with the object of measuring and tabulating the quantity of flow of all the principal streams of the country. This engineering department, which is called the Hydrography Division of the Geological Survey, embraces among its members many of the best well known and foremost men in the profession. They have already accomplished very much, and the statistics gathered as to the flow of streams, the evaporation from water surfaces, etc., are found to be invaluable. Data such as are collected by this corps of men are of great value, as the researches cover a period of time long enough to determine beyond doubt that the results given are correct in every detail, and that they can be absolutely relied on.

In making an estimate of a water-power it is essential that accurate information be had on the following points:—

(1), The flow of the stream, both maximum and minimum.

(2), The total fall at the power site selected.

(3), The practicability of providing storage.

(4), A record of the periods of drought.

The flow of the stream is the one thing most apt to be overestimated, for with a knowledge of a stream covering only a short period of time it seems to be a most natural thing to forget that the minimum or dry summer flow is only a fraction of the average flow of the stream, and consequently if a mistake is made in designing or construction of a water-power it is generally an over-estimate of the power to be derived from the plant installed. Up to the present time no such data regarding stream flow of any kind for Canadian streams have been collected, but I have no doubt but that in the near future the rapid development of the country will lead the government to undertake a work which would lead so directly to the further employment of capital and tend to increased prosperity.

Of Nova Scotia rivers the Mersey is probably the largest, and it is certainly the one best adapted for the development of

water-powers. The main source of the river is in Annapolis county, approximately 15 miles from the Bay of Fundy. Branches to the main stream also come from the counties of Shelburne and Digby. The extent of territory drained by the river is 600 square miles, and on the water-shed are to be found many lakes of large size, of which Rossignol, which has an area of 18 square miles, is the largest. In all, about 40 square miles of lakes are drained by the Mersey, and consequently the river is much more steady in its flow than others of our rivers, due to the large area of lake surface on its water-shed. It will readily be seen that this steadiness of flow particularly adapts this river for the development of water-powers, but after all, the chief recommendation of the Mersey river is the fact that in the last sixteen miles of its length it has a total fall of 260 feet. The river for this portion of its length is really a succession of many rapids or falls, and as the high ground approaches close to the river, on both banks there are many good power sites to be found, capable of development at a comparatively low cost. The portion of the Mersey river which I speak of as being specially adapted for water-powers, is the last sixteen miles of its length, from the point where it leaves the lake (known as Indian Gardens) down to tide water, and I intend giving a short description of the water-powers already developed on this portion, as well as the possibilities of the further development and its application to industries particularly suited to the locality.

In the early days the Mersey river was used by the Indians as a means of communication with the Atlantic coast. The route followed was up the Lequille river to its source in a lake about 14 miles back, and thence by a short portage of about one mile to the head waters of the Mersey, from which point it was comparatively easy to descend by canoe to the ocean at the mouth of the Mersey. That this route was used extensively by the Indians there is abundant evidence in the relics to be found on the shores of some of the lakes on the river, and

guides will now point out what are known as the "picture rocks," so named because of the rude Indian drawings made with some hard tool on the flat surface of the rocks on the shore of "Kidjmie Kidjie" or Fairy lake.

The water-shed of the Mersey is covered with a good growth of nearly every variety of our native trees, and the many branches of the river afforded such an easy mode of transporting the logs that lumbering operations on the river have always been prosecuted with vigor since the days of early settlement, and up to the year 1893 this was practically the only use made of the splendid water-powers on this river. As the great consideration of the owners of saw mills was to deliver the sawn lumber as near navigable tide water as possible, and as the quantity of power required was not large, they were content to utilize heads of 8 to 10 feet, and leave the larger power developments for the future. Accordingly the saw mills were built on two dams about one mile apart, the lower dam being situated just above the tide water at Milton Falls, about 2¼ miles above the town of Liverpool, from which place the lumber has always been shipped.

In the year 1883 an engineer named Emil Vossnack, made surveys and plans for the development of the water-power at two sites immediately above the flowage of the Potanoc or upper saw-mill dam. His purpose was to construct two dams, one at Cowie's Falls, and another at the head of Rapid Falls, and his estimate of the power to be obtained from both was 10,000 horse-power. A company was organized in London to undertake the construction of the two dams, and the necessary mill buldings, etc., for the manufacture of pulp and paper. This company acquired all the necessary lands, etc., for the construction of its dams and factories, but for some reason construction was never started, and nothing further was done until the year 1893, when the Acadia Pulp and Paper Company, recognizing the very cheap power to be got, and the great possibilities of its adaption to the manufacture of

mechanical pulp, acquired the rights of the old company, and commenced the building of a pulp mill at the Rapid Falls site. In the year 1900 the same company extended their operations by building a second dam and mill at Cowie's Falls, immediately below the first one.

For the purpose of supplying power to generate electric current for its lighting system, and motive power for manufacturies, the town of Liverpool in 1903 acquired the water-power on the river immediately above the Acadia Pulp Company's property at the falls known as "the Guzzle," and have constructed an up-to-date electric plant operated under a 20 foot head. This plant owned by the town was a much more costly plant to develop than those below it on the river, as the dam and power-house are over three-quarters of a mile apart, still even with the heavy cost of construction, the cost of power to the town of Liverpool per horse-power is comparatively light, and the town is operating a successful and up-to-date plant.

I give below a short description of the water-powers at present on the river, beginning at the one lowest, and going up the river.

Water-power of the Mersey River.

Milton Falls.—Situate in Milton, just above tide-water, $2\frac{1}{4}$ miles from Liverpool. Two good wharves within one mile of the mills. Total height of the fall at low tide 13 feet. Height of dam 7 to 8 feet. Total head developed, 8 to 10 feet, according to height of water in the river. Dam is the ordinary style of timber dam, built of cross sills and pointers.

Mills on these falls are as follows:—

(1), John Milliard's saw mill, two rotaries and one gang, with all the necessary machinery for doing general mill business. Handles lumber, laths, and box stuff of all kinds. Does a large business in dimension timber. Mill cuts from 30 to 35 thousand per day.

(2), Tupper's gang saw mill, purchased by Lewis Miller, of Ingram Port. This mill runs mostly on custom work. Cuts from 10 to 15 thousand per day.

(3), Power-house of the Milton Electric Power and Manufacturing Co., Ltd. Provides power for lighting the village of Milton, also for Claude Hartlen's wood-working factory and John Wolker's turning shop. 100 horse-power developed.

Total power developed on these falls, 400 to 500 horse-power. Can be greatly increased by the addition of more water wheels.

Potanoc Falls.—Situate in the village of Milton, distance from Liverpool 3¼ miles. The dam at Milton Falls backs water to the foot of this dam. Available head 8 to 10 feet. Height of dam 7 to 8 feet. Dam built of logs, cross sills and pointers. Mills on this dam are as follows:—

(1), Harlow & Kempton's gang and rotary saw mills. Fitted up with all the necessary machinery for doing a first-class saw mill business, capable of getting everything out of the log. Cuts lumber and dimension stuff of all kinds, as well as laths and box stuff.

(2), Harlow & Kempton's wood-working factory, manufacturing sashes and doors, boxes, mouldings, and house finish of all kinds.

(3), L. H. Minard gang saw and planing mill. Besides cutting his own stock this mill also does custom work.

(4), Ford Brothers' rotary mill. Lately purchased by Geo. P. MacLearn. This mill has been principally used in cutting hardwood, for which there is a good demand.

Total power developed on these falls about 450 horse-power. Capacity of mills about 50 thousand daily.

Cowie's Falls.—Situate immediately above the Potanoc Falls, about 3½ miles from Liverpool. The dam at the Potanoc Falls backs water up to the foot of this dam. Height of dam 20 feet, built of logs. Available working head 20 to 22 feet.

Mill owned by Acadia Pulp and Paper Company, manufactures ground pulp. 1500 horse-power developed. Daily output of mill 22 to 25 tons.

Rapid Falls.—Distance from Liverpool $4\frac{3}{4}$ miles. Height of dam 10 feet, built of logs. Available working head, 32 feet. This power was developed by building a dam at the head of Rapid Falls and diverting the water bv means of a canal excavated in the high ground, to a point about 1400 feet down stream, at which place the mill is situated. Total power developed, 2,827 horse-power.

This mill is owned by the Acadia Pulp and Paper Co., and manufactures ground pulp. Daily output, 50 to 60 tons. In both these pulp-mills more power could be developed for a large part of the year if additional wheels were installed.

Guzzle Falls.—Town of Liverpool electric power station. Distance from Liverpool about $5\frac{1}{2}$ miles. Height of dam 6 to 8 feet, built of logs. The dam at Rapid Falls backs water up to the tail-race of this plant.

This power was developed by placing a dam at the head of Guzzle Falls and diverting the water by means of a natural channel nearly one-half mile long, into a basin or reservoir with earth embankments from 2 to 18 feet in height. A timber flume, 350 feet in length, passes the water to the wheels. This plant is laid out for further development, the penstock is built for three sets of wheels, only one of which is yet installed. Head 20 feet. 750 horse-power developed. Power stations contain two 250 K. W. Bullock electric dynamos.

The above are all the water-powers so far developed. They occupy a total length along the river of $3\frac{1}{4}$ miles, and the total of all the different heads, together with an allowance made for some fall that is unavoidably lost to prevent the flowage of one dam interfering with the tail-water of the mill above it, will be in the vicinity of 100 feet. As before mentioned the Mersey river has a total fall in about 16 miles of 260 feet, so it will

be seen that there is still left undeveloped on this river a total fall of approximately 160 feet, extending over a length of river of about 13 miles. In this length of 13 miles there are at least three possible power sites, namely, Lower Great Brook Falls, Big Falls and Lake Falls. All of these are good powers, and the site at Big Falls is probably the largest water-power on the river. The falls have been named in their order going up the river, and the distances from Liverpool are respectively 8 miles, 12 miles and 18 miles.

Power at Present Developed.

A summary of the power developed on the Mersey river at the present time is given below:—

Milton Falls	....	400	horse-power.
Potanoc "	....	450	"
Cowie's "	....	1,500	"
Rapid "	....	2,827	"
Guzzle "	....	750	"

By these figures is meant that wheels to develop the power enumerated here have been installed, or, as in the case of the Liverpool plant that flumes, etc., of capacity large enough for that amount of power have been constructed. What I do not wish, however, to convey is the idea that these plants are developing the amount of power mentioned every day in the year, for they are doing that for probably only nine months on the average in each year, and the minimum power in the dry period is very likely only 25 per cent., or less, of the quantity mentioned. I want to show, however, that each of the power plants at present in operation is capable of much further development when advantage is taken of the immense natural storage that nature has so liberally provided. The question of storage is so intimately connected with the Mersey Hydraulic Company that I must first attempt a description of that company and its powers.

Mersey Hydraulic Company.

The Mersey Hydraulic Company is a company incorporated in the year 1902, and formed for the purpose of improving the water-powers on the Mersey river. It is given power in its act to acquire lands around the lakes, to build dams, etc., and to store water in the lakes on the Mersey river for the purpose of using it or selling it for power purposes, or for other uses. The company has, since incorporation, expended in the vicinity of $20,000 in acquiring flowage lands, building dams, etc., but for some reason unknown to the writer, the dams for flowage are in an incomplete state, and accordingly, it is unable at present to give anything like the increase of power that might be got. A small expenditure of not over $5,000 would suffice to do all the necessary work to enable it to store water over an extremely large area, and when I say that the completion of one dam will store water in three lakes aggregating 22 square miles in area and a depth of six feet, it will readily be seen what large increases of power may be got from storage. Besides, water can readily be stored in other lakes if it is wanted. The effort made so far by the Mersey Hydraulic Company to increase the power on the river from storage, has not been an unqualified success, and the writer cannot explain why this is so. I think, however, it must be admitted that the possibilities of improvement are there, and some change in the management or policy of the company may be arrived at that will benefit and give satisfaction to all the operators on the river. I have heard it advocated that the government should take control of the situation, but that, to my mind, would not be the solution of the difficulty. The great object, first of all, is to get more mills in operation, and when once you have more owners of factories looking for the maximum continuous power to operate their mills, then you will have a board of control that will either dictate to the Mersey Hydraulic Company or merge itself into

the company, or be able to make such strong representations that the government will enact such legislation as will enable the most to be got out of the water-powers. As for the control, I should say it should certainly be in the hands of the owners of the water-powers, both to assess the proportion of expense to be borne by each, and to direct the situation generally. One thing to me seems sure, advantage must be taken of the very large storage before the greatest benefit is obtained from the water-powers on this river. I have already stated that 5,927 horse-power is developed in the river, but for three-month dry period in each year this much is not obtained. Now were the full storage properly developed and distributed, not only could a larger amount of power be obtained every day in the year, but every mill owner would feel warranted in adding additional wheels for the sake of the power to be got for two-thirds of the year.

I would put the estimate of continuous power to be obtained on the Mersey river as follows:—

Powers at present developed..	7,000	horse-power.
Undeveloped powers	8,000	"
Total.............	15,000	

The above is a very conservative estimate, and one I am perfectly sure can be obtained. In making the estimate I am supposing that the storage capacity is fully utilized, and the stored water distributed over the dry summer period. This is a very large amount for continuous power, and were it all fully utilized for manufacturing purposes, this part of the country would become one of the most prosperous and populous in the province. For many manufacturing purposes it is sometimes quite satisfactory if the mills can operate eight or nine months out of the year. This might be the case with saw-mills or even with ground-pulp mills, and if I were to estimate the amount of power that it was possible to develop on the river under that condition I would put it at not less than 40,000 horse-

power. Even at the figure 15,000 the power to be got is enormous, and with the aid of electricity it can be adapted to almost any and all purposes, both close at hand or at a considerable distance away.

The writer made a trip last summer down the Mersey river and was at that time very much impressed with the great possibilities for water-power development, and the more I have thought over it since the greater has been my wonder that it has not been taken advantage of. The Mersey has always been one of our best rivers for lumbering operations, and many millions of feet have annually been shipped away to all parts of the globe. Almost the whole of the lumber, however, has gone in a rough state, and is manufactured in other places; and this is just the point which I cannot reason out, for why should the real manufacture of this lumber be done in other places when the Mersey furnishes power at one-quarter the average cost in other places. It would seem to me that there are almost unlimited possibilities in the manufacture of wooden ware of all kinds. Besides all the articles in hard and soft wood required for the building trade, there are innumerable smaller articles that could be made, such as broom handles, tool handles, pegs and lasts, etc., in fact, no article so small as long as it uses up all the good parts of the wood, and there is no waste as there is when only rough lumber is shipped. There is plenty of room, and lots of the best hardwood for a good furniture factory. Hitherto, immense quantities of hemlock have been cut on this river, and as the logs are stripped of bark before they are rafted, the hemlock bark has been lost altogether, but with a tannery on the river, or even improved facilities for getting it out, another profitable industry could be started. I shall not enlarge on the pulp industry, for it seems to have been well demonstrated already, although perhaps, more mills might be added. I think, however, my remarks about the product of the saw mills might well be applied to the pulp mills also, that is, that the process of manu-

facture should be carried further and paper manufactured. The further the process of manufacture is carried forward the larger the number of men employed, and the more money left in the country for circulation. I should not presume to dictate to our lumber merchants, who I know full well are among our best business men, and yet it may be in certain of our industries we, as Nova Scotians, have got into a "rut." Our neighbors to the south are particularly quick to see a good business opening, and if the Nova Scotians are to keep up in the race they too must keep alive and take advantage of every possible opportunity. This, too, is an age of big things, to get the most out of them, our industries must be on a larger scale, and in the case of these water-powers the ideal state of things would be that one factory should either use the product of another on the river, or some part of the raw material not used by others, and every small particle of our raw material should be manufactured before it is shipped. If we consider the immense tracts of woodland around the Mersey, it can be satisfactorily demonstrated that the forest growth is practically inexhaustible if properly looked after and protected from fires, so that any industry located on the river for the manufacture of anything in the line of wood would be an established fixture. The further the process of manufacture is carried on the less the cut of logs is likely to be, for nothing could be so destructive to our forests as the way they have been depleted for the cutting of deal.

I have said nothing so far about industries connected with anything but lumber, as that seems the most natural use to put the power to, as well as the most profitable. There are, however, other uses for power if transmitted to the mines in the country, for Queens county is rich in minerals, and its gold mines are particularly valuable. In fact, electricity can be so cheaply developed on this river that it can be delivered by long transmission lines at comparatively small cost.

Facilities for Transport.

One of the greatest considerations with the manufacturer of any kind of goods is the proximity of his factory to his market, and the cost of getting his product transported. A manufacturer may be situated at quite a distance from where his goods are sold, and yet, if he has good communication and cheap rates of freight he may be better situated than if he were much nearer his market but had poorer transport facilities. Now I want to show that as regards the powers of the Mersey any manufacture can be readily marketed, and, in fact, I think the situation could hardly be improved, and that it only requires that the conditions become better known to have it promptly taken advantage of. As stated before, the towns of Liverpool and Milton are but 2½ miles apart. Liverpool is the shipping port, while the bulk of the manufacturing has always been done at Milton. There has always been a friendly rivalry between these two places, but to an outsider they are all the same, a people busy, industrious and enterprising to no common degree. That the people of these places have always had faith in their towns, and in their prospects, is evidenced by the uncommon number of neat and pretty residences, and a stranger to the place cannot but be impressed with the care and taste displayed in the arrangement of the grounds and the placing of beautiful shade trees. They have an air of prosperity not always worn by towns of their size. The town of Liverpool has an excellent harbour opening out into the Atlantic, and has exceptional advantages as a shipping port. In the town there is an up-to-date machine shop and foundry, and other factories. They have also a marine railway operated by electric power supplied by the town, and this is the only marine railway on the continent that is so operated. Ship-building is carried on extensively in the town, and the products of the ship-yards are in demand as being the staunchest and best models of wooden ships obtainable.

Milton occupies both sides of the river where it has been broadened out by dams, and is one of the busiest places to be found in the province. The buzz of machinery is heard all over the place, and everybody appears busy and contented. Soon after the starting of the pulp mills a steam tramway was built up the left bank of the river, connecting the mills with the different wharf properties in Liverpool, and has been used to ship the products of the mills, although pulp has been the staple freight outward and pulp-wood inward. I am of opinion that this tramway could be more economically and best operated by electricity, and I feel there will not be any great difficulty in extending this line up the river as far as Indian Gardens, and if this were done every water power on the river could be profitably utilized, for, with more patronage for the road, cheaper freight rates could be had, and with cheaper freight rates and plenty of freight to carry, both tramway and the manufacturer should make money. It does not seem that a factory situated anywhere on the Mersey would pay any more freight per ton for its product delivered on the wharf ready for shipment than many concerns not so favourably situated do for truckage. Now, the rates for water carriage are, as a rule, very much below the rates for rail carriage, and any concern so situated as to be able to ship by water has an immense advantage in marketing its product. As Liverpool harbour is open all the year round, no better shipping port could be desired, and manufactured products from any mill or factory situated in Liverpool or vicinity should be able to successfully meet in competition with those from any other place.

The town of Liverpool supplies electricity for power purposes at a very low rate as an encouragement to manufacturers. There is still room for industries requiring a moderate amount of power in the town, and there seems to be every advantage in the location, cheap power, cheap water and light, and low rate of taxation. Since starting this paper I have learned that construction is already started on a paper box and paper mill at

Milton. It would seem that the manufacture of these articles in the place would be an added inducement to other factories which use paper boxes to hold their product, to locate here, as they must get this part of their material at a cheap rate.

The counties of Queens and Shelburne were so long without railway communication that hitherto their natural advantages were not so widely known as they should have been, and there was perhaps some excuse for the undeveloped state of this part of the country. There have been, perhaps, a further excuse that there was no useful work for these great natural powers to do, but now that the old state of things is no more, and there is good and free communication by rail with all parts of the province, coupled with the fact that at present there is a decided activity in Canada in all industrial pursuits, the magnificent water-powers on this river should not lie idle any longer, and I think it is safe to predict that with a little judicious advertising to make the situation known, all the water now going to waste will be harnessed to some useful work, and the Mersey river, from its mouth to the Indian Gardens, will have a succession of large mills and factories along its banks, making all kinds of goods for shipment abroad, and disbursing enough in wages to sustain many times the present population.

Although the Mersey is undoubtedly the best water-power stream in the province, yet it must not be forgotten that there are many other excellent powers on other streams, and even in the same county of Queens there are several water-powers both developed and undeveloped. The Mersey powers, however, are exceptionally well sustained, both as regards getting the raw material to the factory, and the shipment of the manufactured product, and this fact would, I think, commend them to anyone looking into the situation. I may say that I hold no "brief" to speak for anyone or for any interest on the river. I have, however, had it impressed upon me as the result of a few weeks

spent in this vicinity, that the powers on this river are likely to become important factors in our commercial life, and a source of wealth and profit to the owners as well as to our native province.

I think that we as Nova Scotians are beginning to realize that our province is rich in its resources, and I am firmly convinced that we as yet have only begun to find out how very rich they are. We hear much of the boundless possibilities of western Canada, and are, perhaps, too apt to give too little attention to the development of the eastern portion, but there is no doubt that if we would only emulate the push and energy displayed in opening up the west, and at the same time take full advantage of all the great natural advantages at our disposal, this fair province could be made as prosperous and populous a country as any part of the British dominion.

In preparing this short paper I have been forced to put several friends under tribute for information needed. I am indebted to the provincial engineer, Mr. MacColl, and to the Hon. Justice Forbes, for much help, but I am especially indebted to Mr. John S. Hughes, pulp manufacturer of Milton, for much detail information that could only be acquired by one who had a long and intimate acquaintance with conditions on the river.

WATER-ROLLED WEED-BALLS, SEA-BALLS, BURR-BALLS, OR VEGETABLE-BALLS,
Collected near Upper Kinsgburg, Lunenburg County, Nova Scotia.
(To illustrate paper by Dr. MacKay.)

(Face p. 667)

WATER-ROLLED WEED-BALLS.—BY A. H. MACKAY, LL. D., F. R. S. C., Halifax.

(Read 21st May, 1906.)

In February, 1906, I received a letter and a "sea-ball" from the teacher at Upper Kingsburg, Lunenburg county, a school section in the north-eastern angle formed by the river LaHave and the coast. The pupils were described as "fairly burdened with curiosity" about the strange things cast up by the sea on this sandy beach on the Atlantic. The west bank of the great LaHave, running at right angles into the ocean until it reaches Gaff Point, where it is submerged to rise further out in the far-famed Ironbound Island, protects this bit of shore from the full force of the south-westers.

The teacher, Miss Mary L. H. Bowers, describes the natural history of this beach in terms of the folk-lore of the coast as follows:—

"For years back, the weeds cast upon these shores were of the larger kinds, such as Rockweed, Irish Moss, and Kelp or Laminaria. Sea urchins were the pest of the lobster fishing. About three years ago the sea cast up such immense numbers that the whole coast was abundantly supplied with fertilizers for the farms. This wholesale destruction of animal and vegetable life was looked upon as something which could not be explained. Since then, however, the lobster fisherman believes that the sea bottom shows fewer clean spots of sand, and a great increase of the finer thread-branched sea-weeds. Last year great quantities of red sea-weeds have been thrown ashore; and now, this winter, these 'sea-balls,' as they are called, are being cast up, and the people declare it to be a new thing. Some take them to be the nests of shell fish. In proof, as many as 400 minute shells, taken to be the young of clams, have been counted out of the centre of one of these balls. But then the most of them have few or no shells within them. I have seen perhaps two hundred balls on a short strip of beach, of various sizes, and in different stages of perfection, specimens of which I am sending you."

These "sea-balls" are photogravured on the accompanying plate, with a scale which allows them to be exactly measured.

The last one in the third horizontal row is cut in two, but shows nothing in the centre different from the rest of the ball.

These specimens varied from spheres about five inches in diameter to one and a half inches. Some were elongated. The one on the right, in the upper row, has a frond of *Laminaria digitata* Lamx. passing through the centre of the ball in its longest direction, and has in addition at its opposite polar extremities, *Dictyosiphon fœniculaceus* Grev. growing on a fragment of a waterworn clam shell, and other similar filamentous branching algæ, not worn off, as they are in the compact equatorial region. A little more rolling in water over the sand, or by the wind over the dry beach, would likely soon wear off the appendages down to a compact spheroid.

Some of the balls contain the roots of one of the larger seaweeds within them, one a mass of *Corallina officinalis* L. Others contain embedded in them, various red sea-weeds, and even masses of marine sponges. But they appear to be built up mostly of the filamentous and fine branching olive brown algæ, such as *Dictyosiphon, Desmarestia, Ectocarpus, Chordaria* and *Chorda,* with specimens of nearly every other local species of seaweed, including material to which they were attached when growing, or with which they might become entangled when massing into balls.

Their structure in the different forms examined suggest their formation from light ridges of algæ left by the retreating tide on the flat sandy shallows. Under the sun the weeds curl and lock into masses which, when moved over the sand by alternate tides and winds, occasionally produce very round balls. It would appear that the filamentous and fine branching olive-brown algæ are more brittle than many of the red species which are often found like the larger olive algæ, extending beyond the general contour of the rolling ball.

Mr. Harry Piers, curator of the Provincial Museum, has received a similar ball, collected by Mr. J. Perrin, from the

sandy beach on MacNab's Island at the mouth of Halifax Harbor, where others were noted, and also a specimen from a fresh-water lake near New Ross, Lunenburg county.

Mr. P. B. Lantz, of New Ross, Lunenburg county, has found them in a fresh-water lake near the head of Gold River, and in Indian Lake in New Germany. The people think they are nests made by the water newts found in these lakes—probably the aquatic stage of *Diemyctylus viridescens* Rafinesque—just because these two objects are the two mysterious things found together in the same place. The fresh-water balls are spoken of as the nests of the newts or as burr-balls, the former suggested by the proofless, popular hypothesis referred to, the latter by their appearance.

Professor W. F. Ganong read, 3rd May, 1904, a paper "On Vegetable-, or Burr-, Balls from Little Kedron Lake, N. B.," which is published on page 304, vol. v., part iii., no. xxiii., of the *Bulletin of the Natural History Society of New Brunswick* with a photogravure of two balls, one from Lake Kedron and the other from Sandy Pond in Lincoln, Massachusetts. The former was found in a sandy cove of the lake, open to no wind except from the south-east. The cove is surrounded with fir and spruce, whose leaves fall into the water. The balls are composed chiefly of these leaves, including other vegetable matter, such as small twigs, etc., all interlocked together. The latter, from Flint's or Sandy Pond, was composed mainly of the tangled stems and leaves of the Duck grass *(Eriocaulon septangulare)* which was growing in the lake. Thoreau, in chapter ix of his *Walden,* describes this phenomenon in the identical lake in the following words:

"I used to admire the ripple marks on the sandy bottom at the north end of this pond, made firm and hard to the feet of the wader by the pressure of the water, and the rushes which grew in Indian file, in waving lines, corresponding to these marks, rank behind rank, as if the waves had planted them. There also I have found, in considerable quantities, curious balls, composed apparently of fine grass or roots, of pipewort, perhaps, from half an inch to four inches in diameter, and perfectly spherical.

These wash back and forth in shallow water on a sandy bottom, and are sometimes cast on the shore. They are either solid grass, or have a little sand in the middle. At first you would say that they were formed by the action of the waves, like a pebble; yet the smallest are made of equally coarse materials, half an inch long, and they are produced only at one season of the year. Moreover, the waves, I suspect, do not so much construct as wear down a material which has already acquired consistency. They preserve their form when dry for an indefinite period."

Professor Ganong wrote, August 1904, in the *Educational Review* of Saint John, New Brunswick; and 8th April, 1904, in *Science* of New York; asking for references to similar observations; but he obtained at that time only one additional reference to a locality—"a lake in Idaho."

The observations of Miss Bowers on the Atlantic coast near the mouth of the LaHave, and the specimen reported from MacNab's Island, extend our knowledge of the formation to marine waters—even to oceanic beaches. The spheroidal, and even cylindrical, masses point clearly to the action of the water as the main cause. The deposition of a mass of eggs on a roll of such algæ would be one condition to agglutinate into a nucleus a mass which might later contain young marine life within the centre of the future ball. Roots of algæ and other entangling forms are often conspicuous as nuclei. But often the whole mass appears to be composed of the more attenuated olive-brown algæ. Although an addition has been made to our knowledge, there are still wanting more definite demonstrations of the exact manner in which these ball forms are originated as well as rounded. The phenomenon must also be occurring more widely than hitherto observed. What has been observed so far suggests as an appropriate title for them: "Water-rolled Weed balls."

APPENDIX IV.

LIST OF MEMBERS, 1905-06.

ORDINARY MEMBERS.

Name	Date of Admission.
Bayer, Rufus, Halifax	March 4, 1890
Bishop, Watson L., Supt. of Water Works, Dartmouth, N. S.	Jan. 6, 1890
Bowman, Maynard, B. A., Public Analyst, Halifax	March 13, 1884
Brown, Richard H., Halifax	Feb. 2, 1903
Budge, Daniel, General Supt. Halifax & Bermuda Cable Co., Halifax	Oct. 30, 1903
*Campbell, Donald A., M. D., Halifax	Jan. 31, 1890
Campbell, George Murray, M. D., Halifax	Nov. 10, 1884
Colpitt, Parker R., City Electrician, Halifax	Feb. 2, 1903
*Davis, Charles Henry, C. E., New York City, U. S. A	Dec. 5, 1900
Dixon, Prof. Stephen Mitchell, B. A., B. A. I., University of Birmingham, Birmingham, England	April 8, 1902
Doane, Francis William Whitney, City Engineer, Halifax	Nov. 3, 1886
Donkin, Hiram, C. E., Glace Bay, C. B.	Nov. 30. 1892
Egan, Thomas J., Halifax	Jan. 6, 1890
Fearon, James, Principal, Deaf and Dumb Institution, Halifax	May 8, 1894
*Forbes, John, Moncton, N. B.	March 14, 1883
*Fraser, C. Frederick, LL. D., Principal, School for the Blind, Halifax	March 31 1890
Gates, Herbert E., Architect, Halifax	April 17, 1899
*Gilpin, Edwin, M.A., LL.D., F.R.S.C., I.S.O., Inspector of Mines, Halifax	April 11, 1873
Hattie, William Harrop, M. D., Supt. N. S. Hospital, Dartmouth	Nov. 12, 1892
Hayward, A. A., Halifax	Nov. 7, 1905
Irving, G. W. T., Education Dept., Halifax	Jan. 4, 1892
Jack, Prof. Ernest Brydone, M. A., C. E., Dalhousie College, Halifax	Nov. 7, 1905
Johnston, Harry W., C. E., Asst. City Engineer, Halifax	Dec. 31, 1894
*Laing, Rev. Robert, Halifax	Jan. 11, 1885
McCarthy, J. B., B. A., M. SC., teacher of science, County Academy, Halifax	Dec. 4, 1901
McColl, Roderick, C. E., Provl. Engineer, Halifax	Jan. 4, 1892
Macdonald, Simon D., F. G. S., Halifax	March 14, 1881
*MacGregor, Prof. James Gordon, M. A., D. SC., F. R. S., F. R. S. C., Edinburgh University, Edinburgh, Scotland	Jan. 11, 1877
McInnes, Hector, LL. B., Halifax	Nov. 27, 1889
*McKay, Alexander, Supervisor of Schools, Halifax	Feb. 5, 1872
*MacKay, Alexander Hector, B. A., B. SC., LL. D., F. R. S. C., Superintendent of Education, Halifax	Oct. 11, 1885
MacKay, Prof. Ebenezer, PH. D., Dalhousie College, Halifax	Nov. 27, 1889
*MacKay, George M. Johnstone, Dartmouth, N. S	Dec. 18, 1903
MacKenzie, Prof. Arthur Stanley, Ph. D., Dalhousie College, Halifax	Nov. 7, 1905
McKerron William, Halifax	Nov. 30, 1891

*Life Members.

Date of Admission.

Marshall, Gilford R., Principal, Compton Avenue School, Halifax .... April 4, 1894
Morton, S. A., M. A., County Academy, Halifax .... Jan. 27, 1893
Murphy, Martin, C. E., D. SC., I. S. O., Saskatoon, Sask .... Jan. 15, 1870
Murray, Prof. Daniel Alexander, Ph. D., Dalhousie College, Halifax .... Dec. 18, 1903
*Parker, Hon. Daniel McN., M. D., Dartmouth, N. S............ 1871
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax .... Nov. 2, 1888
*Poole, Henry Skeffington, A. M., ASSOC. R. S M, F. G. S, F. R. S. C, M. CAN. SOC. C. E., HON. MEM. INST. M. E., Halifax .... Nov. 11, 1872
Read, Herbert H., M. D., L. R. C. S., Halifax .... Nov. 27, 1889
*Robb, D. W., Amherst, N. S .... March 4, 1890
Rutherford, John, M. E., Halifax .... Jan. 8, 1865
Sexton, Prof. Frederic H. Dalhousie College, Halifax .... Dec. 18, 1903
*Smith, Prof. H. W, B. SC., Agricultural School, Truro, N. S.; Assoc. Memb., Jan. 6, 1890 .... Dec. 1900
*Stewart, John, M. B. C. M., Halifax .... Jan. 12, 1885
Tinling, Captain E. B., R. N., Marine & Fisheries Dept., Halifax ...... Feb. 7, 1905
Wheaton, L. H., Chief Engineer, Coast Railway Co., Yarmouth, N. S.... Nov. 29, 1894
Wilson, Robert J., Secretary, School Board, Halifax .... May 3, 1889
Winfield, James H., Manager, N. S. Telephone Co., Halifax .... Dec. 18, 1903
Woodman, Prof J. Edmund, M. A, D. SC., School of Mining and Metallurgy, Dalhousie College, Halifax .... Dec. 3, 1902
*Yorston, W. G., C.E., City Engineer, Sydney, C. B .... Nov. 12, 1892

ASSOCIATE MEMBERS.

Archibald, Monro, B. A., B Sc, Truro, N. S. .... Nov. 7, 1905
*Caie, Robert, Yarmouth, N. S .... Jan. 31, 1890
*Dickenson, S. S., Commercial Cable Co., New York, U. S. A............ March 4, 1895
Edwards, Arthur M., M. D., F. L. S, Newark, N. J .... Dec. 12, 1898
Gates, Reginald R., Mt. Allison University, Sackville, N. B .... Feb. 2, 1903
Haley, Prof. Frank R, Acadia College, Wolfville, N. S .... Nov. 5, 1901
Harlow, L. C., B. SC., Prov. Normal School, Truro, N. S .... March 23, 1905
Haycock, Prof. Ernest, Acadia College, Wolfville, N. S .... May 17, 1899
Hunton, Prof. S. W, M. A. Mount Allison College, Sackville, N. B .... Jan. 6, 1890
Jaggar, Miss A Louise, Cambridge, Mass .... Dec. 5, 1900
James, C. C., M. A., Depy. Min. of Agriculture, Toronto, Ontario ...... Dec. 3, 1896
Jennison, W. F., Sydney, C. B .... May 5, 1903
*Johns, Thomas W., Yarmouth, N. S .... Nov. 27, 1889
*Keating, E. H., C. E., Toronto. Ry. Co, Toronto, Ont.; Ord. Memb. April 12, 1882 .... April 11, 1900
*Kennedy, Prof. Geo. T., M. A., D. SC. F. G. S., Wolfville, N. S .... Nov. 9, 1882
Lawrence, H., D. D. S., Wolfville, N. S .... March 9, 1903
McIntosh, Kenneth, St Peters, C. B.; Ord. Memb, Jan. 4, 1892....... June 1900
*MacKay, Hector H., M. D., New Glasgow, N. S .... Feb. 4, 1902
McKenzie, W. B., C. E., Moncton, N. B .... March 31, 1882
McLeod, R. R., Brookfield, N. S .... Dec. 3, 1897
Magee, W. H., PH. D., Annapolis, N. S .... Nov. 29, 1894
Matheson, W. G., New Glasgow, N. S .... Jan. 31, 1890
Payzant, E N., M. D., Wolfville, N. S .... April 8, 1902
Pineo, Avard V., LL. B., Kentville, N. S .... Nov. 5, 1901
*Reid, A. P., M. D., L. R. C. S., Middleton, Annapolis Co., N. S .... Jan. 31, 1890
*Robinson, C. B., B.A., New York Botanical Garden, New York, U. S. A..Dec. 3, 1902
*Rosborough, Rev. James, Musquodoboit Harbour, N. S .... Nov. 29, 1894

*Life Members.

Date of Admission.

Russell, Prof. Lee, B. S., Worcester, Mass....................Dec. 3, 1896
Sawyer, Prof. Everett W., Acadia College, Wolfville, N. S....................Feb. 6, 1901

CORRESPONDING MEMBERS.

Ami, Henry M., D. SC., F. G. S., F R. S. C., Geological Survey, Ottawa, Ontario....................Jan. 2, 1892
Bailey, Prof. L. W., PH. D., LL. D., F. R. S. C., University of New Brunswick, Fredericton, N. B....................Jan. 6, 1890
Ball, Rev. E. H., Tangier, N. S....................Nov. 29, 1871
Bethune, Rev. Charles J. S., M. A., D. C. L., F. R. S. C., Ontario Agricultural College, Guelph, Ont....................Dec. 29, 1868
Cox, Philip, B. SC., PH. D., Chatham, N. B....................Dec. 3, 1902
Dobie, W. Henry, M. D., Chester, England....................Dec. 3, 1897
Ells, R. W., LL. D., F. G. S. A., F. R. S. C., Geological Survey, Ottawa, Ont..Jan. 2, 1894
Faribault, E. Rodolphe, B. A., B. SC., Geological Survey of Canada, Ottawa; Assoc. Memb., March 6, 1888....................Dec. 3, 1902
Fletcher, Hugh, B. A., Geological Survey, Ottawa, Ontario....................March 3, 1891
Fletcher, James, LL. D., F. L. S, F. R. S. C., Entomologist and Botanist, Central Exp. Farm, Ottawa, Ontario....................March 2, 1897
Ganong, Prof. W. F., B. A., PH. D., Smith College, Northampton, Mass., U. S. A....................Jan. 6, 1890
Hardy, Maj.-General Campbell, R. A., Dover, England....................Oct. 30, 1903
Harrington, W. Hague, F. R. S. C., Post Office Department, Ottawa....................May 5, 1896
Hay, George U., D. SC, F. R. S. C., St. John, N. B....................Dec. 3, 1902
Litton, Robert T., F. G. S., Melbourne, Australia....................May 5, 1892
McSwain, John. Charlottetown, P. E. I....................Dec. 3, 1902
Matthew, G. F., M. A., D. SC., F. R. S. C., St. John, N. B....................Jan. 6, 1890
Maury, Rev. Mytton, D. D., Ithaca, N. Y., U. S. A....................Nov. 30, 1891
Peter, Rev. Brother Junian, Fall River, Mass., U. S. A....................Dec. 12, 1898
Pickford, Charles, Halifax....................March 2, 1900
Prest, Walter Henry, M. E., Webbwood, Ont; Assoc. Memb., Nov. 29. 1894, Nov. 2 1900
Prichard, Arthur H. Cooper, Boston, Mass....................Dec. 4, 1901
Prince, Prof. E. E., Commissioner and General Inspector of Fisheries, Ottawa, Ontario....................Jan. 5, 1897
Smith, Hon. Everett, Portland, Maine, U. S. A....................Mar. 31, 1890
Weston, Thomas C., F. G. S. A., Ottawa, Ontario....................May 12, 1877

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* Life Members.

LIST OF PRESIDENTS

OF THE NOVA SCOTIAN INSTITUTE OF NATURAL SCIENCE, AFTERWARDS THE NOVA SCOTIAN INSTITUTE OF SCIENCE, SINCE ITS FOUNDATION IN 1862.

	Term of Office.		
Hon. Philip Carteret Hill, D. C. L.	31 Dec. 1862	to	26 Oct. 1863
John Matthew Jones, F. L. S., F. R. S. C.	26 Oct. 1863	"	8 Oct. 1873
John Bernard Gilpin, M. A., M. D., M. R. C. S.	8 Oct. 1873	"	9 Oct. 1878
William Gossip	9 Oct. 1878	"	13 Oct. 1880
John Somers, M. D.	13 Oct. 1880	"	26 Oct. 1883
Robert Morrow	26 Oct. 1883	"	21 Oct. 1885
John Somers, M. D.	21 Oct. 1885	"	10 Oct. 1888
Prof. James Gordon MacGregor, M. A., D. SC., F.R.S.. F.R.S.C.	10 Oct. 1888	"	9 Nov. 1891
Martin Murphy, C. E., D. SC., I. S. O.	9 Nov. 1891	"	8 Nov. 1893
Prof. George Lawson, PH. D., LL. D., F. I. C., F. R. S. C.	8 Nov. 1893	"	10 Nov. 1895
Edwin Gilpin, Jr., M. A., LL. D., D. SC., F. G. S., F. R. S. C., I.S.O.	18 Nov. 1895	"	8 Nov. 1897
Alexander McKay	8 Nov. 1897	"	20 Nov. 1899
Alexander Howard MacKay, B. A., B. SC., LL. D., F. R. S. C.	20 Nov. 1899	"	24 Nov. 1902
Henry Skeffington Poole, M. A., D. SC., A. R. S. M., F. G. S., F. R. S. C.	24 Nov. 1902	"	18 Oct. 1905
Francis William Whitney Doane, C. E.	18 Oct. 1905	"	11 Nov. 1907
Prof. Ebenezer MacKay, PH. D.	11 Nov. 1907	"	———

NOTE—Since 1879 the presidents of the Institute have been *ex-officio* Fellows of the Royal Microscopical Society.

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(Roman numerals refer to the Proceedings; Arabic numerals to the Transactions.)

THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science,

HALIFAX, NOVA SCOTIA.

VOLUME XI.

1902-1906.

HALIFAX:
PRINTED FOR THE INSTITUTE BY MCALPINE PUBLISHING CO., LTD.
1908.

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